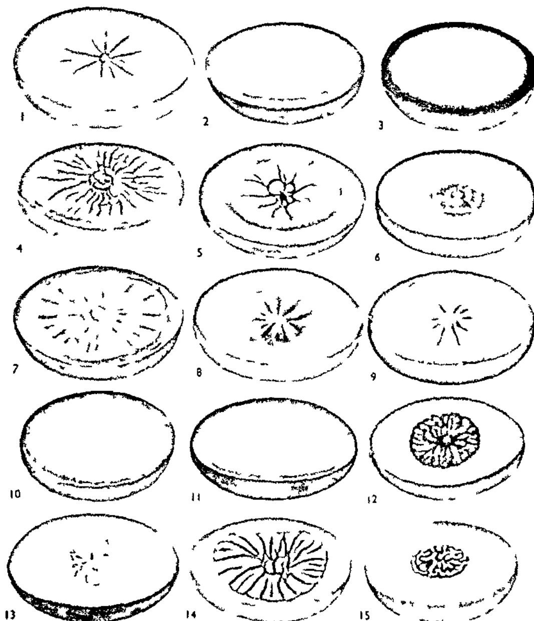
GIANT COLONIES OF RINGWORM FUNGI
(Sabouraud's Maltose Agar)



(1) *Microsporum audouini* (2) *M. canis* (3) *M. gypseum* (4) *Epidermophyton floccosum* (5) *Trichophyton tonsurans* (6) *T. sulphureum* (7) and (9) *T. purpureum* (8) *T. purpureum* (Glucose agar) (10) *T. mentagrophytes* Gypseum (11) *T. interdigitale* (12) *T. violaceum* (13) *T. schoenleini* (14) *T. ferrugineum* (15) *T. concentricum*

Frontispiece

MEDICAL MYCOLOGY

INCLUDING
LABORATORY TECHNIQUE
AND
THERAPEUTIC RECIPES

By

N C DEY B Sc M B B S (Cal) D Bact (Manchester) F D S (Lond)
Professor of Pathology and Bacteriology Assam Medical College Dibrugarh Author of Medical Parasitology Medical Bacteriology Practical Pathology and Bacteriology etc Examiner in Pathology Gauhati Calcutta Patna and other Universities

FOREWORD
By
Professor G PANJA M B B S (Cal) D B (Lond) F N I
Late of the School of Tropical Medicine Calcutta

WITH THIRTYEIGHT PLATES THREE COLOURED
AND FORTYSIX TEXTFIGURES

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FOREWORD

I have great pleasure in writing a foreword to the book on Medical Mycology by Professor N C Dey of the Assam Medical College The author was a colleague of mine in the Calcutta School of Tropical Medicine for many years [He devoted himself whole heartedly for several years in the study of Dermatology and isolation of pathogenic fungi from skin diseases and published a large number of original articles Having thus gained considerable experience he has fully utilised his knowledge in the production of this book The book has been amply illustrated with plates text figures coloured plates and diagrams collected and prepared during the long period of his work in the School as well as in the Assam Medical College The speciality of the book is that the author has followed a natural classification of fungi pathogenic to man The laboratory methods mentioned in the book are those which were found to be useful by the author while working in the School of Tropical Medicine Calcutta

I congratulate the author for sparing no pains in the production of such a valuable book I am confident that his book will be a very useful guide to post graduate students and practitioners for whom it is meant]

Sd/ G PANJA
Late of the Department of Dermatology and
Professor of Bacteriology and Pathology
Calcutta School of Tropical Medicine

The 30th December 1957
117 Vivekananda Road
Calcutta 6

PREFACE

The author regrets very much for the various printing errors in the book sp cially with regard to the word coccidiomycosis in different pages It should be read as coccidioidomycosis

Little importance has been laid on the study of Medical Mycology in the undergraduate course of the Indian Universities The subject has however been recently included as a part of the post graduate curricula of Dermatology and Tropical Medicine of the Calcutta University This has been judiciously done as diseases caused by fungi are not uncommon in India a tropical country

Since the time of the late Lt Col H W Acton then Director The School of Tropical Medicine Calcutta 1932 I have had the opportunity of studying Medical Mycology as an Assistant Research Worker under him and others following him in the Department of Dermatology and Medical Mycology under the Indian Research Fund Association (present I C M R) and also in other places in India including the Assam Medical College Dibrugarh as the Professor of Pathology The articles on these works were published from time to time in Medical Journals in India and the present volume is the result of compilation of those articles There are certain diseases like North and South American blastomycoses coccidioidomycosis etc which have not been authentically recorded in India and these diseases have been compiled from American literatures to make the book complete for the students and practitioners In this volume common diseases caused by fungi in man and animals have been recorded Common laboratory methods have been included in the appendix including certain recipes which might be of help to the medical practitioners The author will consider his endeavour to be amplv rewarded if the book becomes helpful to the students and practitioners in India

The author is thankful to Sri H C Sarkar Manager of Pressagents Private Limited Calcutta for the keen interest he has taken in the production of this volume

Dibrugarh
the 15th December 1957

N C D

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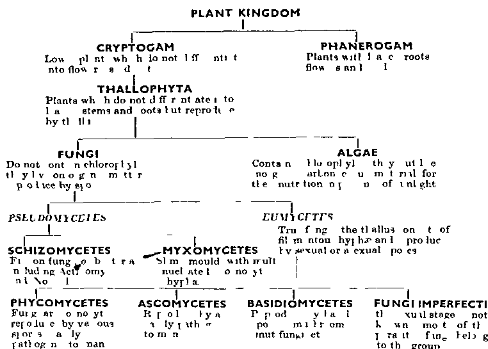
MEDICAL MYCOLOGY

CHAPTER I

INTRODUCTION

The science that deals with the study of fungi is called mycology The position of fungi in the plant kingdom is shown in the following table

TABLE I



Thallophyta are lower cryptogams which comprise two main groups namely—Algae and Fungi Algae are green thallophyta characterised by the presence of chlorophyl which is essential for the synthesis of carbohydrate from carbon dioxide in air in presence of sun light They are therefore *autotrophic* Fungi on the other hand are characterised by the absence of chlorophyl in their cells they are *heterotrophic* They are to depend for their growth on prepared carbonaceous food material from decaying organic matters as *saprophytes* or from the body of

other plants or animals as *parasites* Fungi that grow on the surface of the body are called *ectoparasites* whereas those that grow in the tissue or internal organs are known as *endoparasites* causing systemic mycosis

Schizomycetes (fission fungi) or bacteria are the lowest form of organisms in the vegetable kingdom and like fungi are devoid of chlorophyl These are minute living units 1 μ or less in diameter The question of the presence of nucleus in bacteria is still undecided But the modern trend is to accept that bacteria contain nuclear chromatin which participates in the process of cell division They do not however differentiate into any organ of reproduction although some of them reproduce by endospores

Fumycetes (true fungi) are higher than bacteria but they show visible nuclei plant volutin and reproduce by sexual or asexual spores Fungi resemble bacteria as they lack in chlorophyl but they differ from bacteria morphologically being larger in size than bacteria and show branching Actinomyces and Nocardia which are fungi resemble bacteria being 1 μ or less in diameter but unlike bacteria they show branching and the modern trend is to include the order Actinomycetales under the class Schizomycetes (Bergey 1948)

DEFINITIONS

(I r f i u fe to pl u I)

Mycetes—A fungus

Mycosis—(pl Mycoses) It is a disease caused by fungus

Thallus—The entire vegetative apparatus of the fungus is called a thallus It does not differentiate into roots stems or leaves

Hypha (pl hyphae) (Fig 1) It is a chain of cylindrical cells forming a filamentous structure

Mycelium—(pl mycelia) (Fig 2) It is a felt like mass produced by a collection of intertwined hyphae collectively known as mycelium Mycelia may be surface runners or they may be erect forming aerial hyphae which often bear spores (sporophores)

Coenocyte (Fig 3) Multinucleated mass of protoplasm formed by division of nuclei but without any division of cytoplasm e g Phycomycetes

Rhizoids (Fig 4) Mycelium in certain cases is provided with root like structures called rhizoids e g Rhizopus

Club (Fig 5) The swollen portion of a hypha is called a club

Racquets —(Racquet mycelia) (Fig 6) These are racket shaped cells along the course of a hypha in which the clubbed end of one cell is attached to the thin end of the next cell Mycelial racquets are often arranged in series

Nodular Organs (Fig 7) These are large rounded cells like knots formed by a few chlamydospores (See page 4) with radiating mycelia from the knot

Pectinate bodies (Hyphae pectinate) (Fig 8) These are swollen hyphae often curved and give off a row of abortive branches from one side roughly resembling a comb

Spirals (Fig 9) These are simple hyphae which develop into closely set spirals or coils They simulate tendril like apparatus of higher plants

Fig 1—Hypha



Fig 5—Clubs

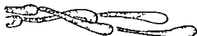


Fig 6—Racquets

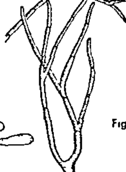


Fig 2—Mycelium



Fig 3—Coenocyte



Fig 4—Rhizoids



Fig 7—Nodular organ



Fig. 8—Pect nate body



Fig 9—Spiral

SEXUAL SPORES



Fig 10—Zygospore

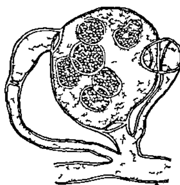


Fig 11—Oospore



Fig 12—Ascocarp





F g 13—Ascospores in asci

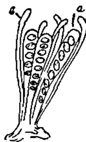
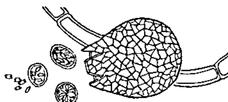


Fig 14—(a) Ascospore
(b) Hymen um



F g 15—Perithecium



Fig 16 Basidiospores

To face page 2

Plate I

(Continued)

ASEXUAL SPORES

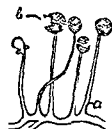


Fig 17
(a) Sporangiophore
(b) Sporangium



Fig 18
(a) Sporangiospore
(b) Columella

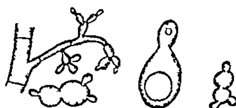


Fig 19—Blastospores

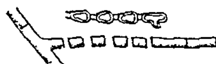


Fig 20—Arthrospore

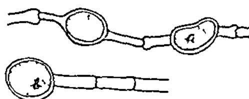


Fig 21
(a) Intercalary chlamydospore
(b) Terminal chlamydospore

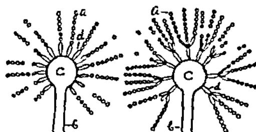


Fig 22
(a) Con dia vera (b) Con d ophore
(c) Columella (d) Sterigma

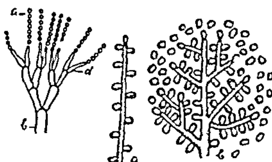
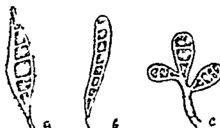


Fig 23—M crocon d a
(a) Thyrse (b) En grappe



F g 24—Macroconid a
(a) Po nted (b) Cyl ndr cal
(c) Blunt end



F g 25—Ph al de
with ph alospore

Spores—Reproductive body of a cryptogam is called a spore The spores may be sexual or asexual Sexual spores are derived from the union of two gametes (Perfect stage) but asexual spores arise from fertile hyphae (Imperfect stage)

SEXUAL SPORES AND ACCESSORY STRUCTURES

Zygospore (Fig 10) It is a sexual spore resulting from fusion of two similar gametes (isogamous) as in zygomycetes

Oospore (Fig 11) It is a sexual spore arising from fertilisation of a female cell by a male cell (two dissimilar gametes) antheridium and oogonium e g Oomycetes in Phycomycetes

Ascocarp (Fig 12) Any fruit body containing asci is known as ascocarp

Ascospores (Figs 13 14) These are sexual spores 4 or 8 in number enclosed in a membrane known as ascus (a *cask* or *case*) The ascus is usually cylindrical but in yeasts it is oval and is formed by fusion of the nuclei of two contiguous cells The fusion is followed by two or three successive divisions resulting in 4 or 8 nuclei which subsequently form 4 or 8 spores by cutting out cytoplasm around the nuclei Ascospores are characteristic of the class Ascomycetes

Hymenium (Fig 14b) It is a tissue formed by a layer of spore producing structure found in the fruit bodies of Ascomycetes The sterile hyphae interposed in the hymenium are known as *paraphyses*

Perithecium (Fig 15) It is a globose fruit body containing organs of fructification interposed with fertile hyphae A perithecium is enclosed in a loosely woven hymenium and shows asci and ascospores in it

Apothecium When the fruit body of an Ascomycetes is wide open like a cup it is called apothecium e g Dyscomycetes

Sclerotia These are composed of compact hard tissue formed by a close network of hyphae and capable of remaining dormant for a long period under unfavourable conditions From this a new mycelium germinates under favourable conditions and bears an organ of reproduction e g sclerotia of *Claviceps purpurea*

Basidiospores (Fig 16) These are sexual spores 4 in number held by peg like structures at the end of a club shaped sporebearing organ known as *basidium* (Pl *basidia*) These are characteristic spores of the class Basidiomycetes

ASEXUAL SPORES AND THE SPORE BEARING APPARATUS

Asexual spores may be endogenous e g sporangiospores or exogenous e g conidia

Sporangiophore (Fig 17) The fertile hypha which bears a sporangium (Spore case) is called a sporangiophore

Sporangiospore (Fig 18) These are asexual spores formed endogenously in a spore case called sporangium e g Mucor

Columella —(small pillar) (Fig 18b) It is the terminal domeshaped swollen part of a sporangiophore bearing a sporangium

The system of classification of spores by Saccardo is not mentioned here It is preferable to follow the system of Vuillemin as modified here and mentioned below

Thallospores Spores arising from thallus (vegetative part of a fungus) are called thallospores These are subdivided into the following types

(a) **Blastospores** (Fig 19) These are spores arising from the vegetative hyphae by a process of budding

(b) **Arthrospores** (Fig 20) Mycelia when old show segmentations by transverse septa at close intervals These segmented mycelia are either cubical or rounded and spores form in them without swelling of the mycelium

(c) **Chlamydospores** These spores are formed by swelling of mycelial filaments The process is associated with condensation of the protoplasmic substance often at the cost of the neighbouring cells with formation of a thick cell wall with double contour They may be intercalary along the course of the hypha (*Fig 21a*) or *terminal at the end of a hypha (Fig 21b)*

Conidiophore (Fig 22b) It is a fertile hypha bearing conidia

Conidia There are several types of conidia True conidia or *conidia vera (Fig 22a) as a contrast to thallospores are borne at the terminal part of a fertile* hypha—a conidiophore These are produced by abstriction of the fertile hyphae The conidia may be basipetal or acropetal In the basipetal type as in the case of *Penicillium the oldest conidia are at the terminal part* and become detached at the slightest disturbance in the acropetal type the oldest cell is in the proximal part of the fertile hypha

Aleuriospores (Microconidia) These are small spores about 3 to 4 μ in diameter borne on fertile hyphae These are sessile Unlike conidia they are liberated only after disintegration of mycelia According to their arrangements they are said to form thyrse i e arranged laterally (Fig 23a) as in *Trichophyton rubrum* or en grappe (Fig 23b) as in *T interdigitale* and *T mentagrophytes* These microconidia may be spherical subspherical or ovoid

Fuseaux (Macroconidia) These are spindle shaped large conidia either terminal or lateral They are nonseptate when young but pluriseptate when old They may be pointed cylindrical or with blunt ends (Fig 24a 24b 24c) These are characteristic of dermatophytes

Sterigma (Fig *22d) These are small stalks bearing conidia often in chains*

Phialide (Fig 25) These are flask shaped stalks borne on sporophores and bear conidia

Phialospores (*Fig 25) Conidia borne on phialides are called* phialospores

Pycnidia These are minute globose or flask shaped fruit body with apical osteoles internally lined by conidiophores as in Sphaeropsidales Conidia are discharged through the osteole in the plant body which they parasitise

Coremia These are stalked bodies of cylindrical shape formed by a cluster of conidiophores which run parallel in a fascicular form e g Stilbaceae

Sporodochium It is a sessile globose fruit body without stalks and contains a collection of conidiophores

Acervuli These are fructifying bodies containing conidiophores packed together occuring in clusters or heaps and form a saucer like mass on the plant host e g Melanchoniales

CLASSIFICATION

I Mycelium non septate coenocytic spores usually borne in a sporangium Sexual fusion results in an oospore or a thick walled zygospore

Class PHYCOMYCETES

II Mycelium septate dimension of mycelia more than 1μ

A Reproduce by Ascospores which are sexual spores The sexual fusion results in formation of an ascus The ascus contains 4 or 8 ascospores

Class ASCOMYCETES

B Reproduce by basidiospore i e sexual fusion results in formation of a club shaped organ called basidium on the surface of which 4 basidiospores are borne by peglike structures attached to the basidium

Class BASIDIOMYCETES

C Reproduce by asexual spores sexual spores unknown

Class FUNGI IMPERFECTI

III Vegetative body 1μ or less in diameter and multiplies by binary fission

Class SCHIZOMYCETES

CLASS I PHYCOMYCETES

Phycomycetes They show nonseptate coenocytic vegetative mycelia and reproduce by both sexual and asexual spores They are divided into three subclasses

I **Archimycetes** These are primitive forms and found as parasites of water plants and animals but may sometimes cause diseases of land plants They mainly reproduce by motile flagellate spores called *oospores* In some cases they form oospores

II **Oomycetes** This subclass is characterised by formation of two dissimilar gametes in their sexual life The oogonium is fertilised either by a motile male sperm or by a specialised nonmotile male germ tube The oogonium or the female organ *when ripe shows aggregation of protopalsm into one or* more *oospheres* After fertilisation the oospheres round up to form *oospores* which often lie free in the oogonium (Fig 11)

III **Zygomycetes** The sexuality of this group of fiungi is characterised by the formation of similar gametes and is called isogamous the process is known as conjugation and the product of union is called a *zygospore* (Fig 10) In the union the ends of two mycelia b come swollen come in contact with each other and the terminal parts of the hyphae are segmented by a transverse wall The similar terminal cells are the conjugating cells (gametes) The walls between the conju gating cells disappear and the protoplasmic masses of both the cells unite forming

a spore called zygospore A zygospore has a double wall which is thick and rough Under favourable conditions a germinating tube called a *promycelium* develops form a zygspore bearing a sporangium containing spores This sporangium is similar to one found in the asexual spores The classification of Phycomycetes is shown below

Subclasses of Phycomycetes

Mycelium absent	Subclass *ARCHIMYCETES*
Mycelium nonseptate (coenocytic)	
A Sexual reproduction heterogamous—	Subclass *OOMYCETES*
B Sexual reproduction isogamous—	Subclass *ZYGOMYCETES*

CLASS II ASCOMYCETES

Ascomycetes The vegetative body of Ascomycetes may be single celled (yeasts) or both yeastlike bodies and hyphae may be present The hyphae are septate Asexual spores or conidia are produced exogenously either from conidiophores or directly from hyphae (blastospores)

The sexual life in Ascomycetes is characterised by formation of specialised endogenous spores called ascospores borne on asci or sacs This is the product of fusion of like or unlike sexual cells The sexual process may not be hidden but naked during development e g true yeasts But in other cases they may be protected and hidden in a specialised structure called perithecium The class is divided into several subclasses as follows

Subclasses of Ascomycetes

1 Asci produced from oogonium or by multiplication of diploid cell	
Ascogenous hyphae absent	Subclass *PROTOASCOMYCETES*
2 Asci borne on fertile ascogenous hyphae (Euascomycetes)	
A Asci in a closed perithecium	Subclass *PLECTOMYCETES*
B Asci in a hymenium	
(i) in an apothecium	Subclass *DISCOMYCETES*
(ii) in a perithecium	Subclass *PYRENOMYCETES*

CLASS III BASIDIOMYCETES

Basidiomycetes The vegetative growths of these fungi show septate filamentous hyphae They reproduce by basidiospores which are sexual spores These are borne exogenously on special club shaped organs called basidia In a typical case a basidium bears four spores held by peg like structures attached to the basidium Mushrooms (toad tool) are fungi of this group Lower fungi of this group are rust and smut fungi

CLASS IV FUNGI IMPERFECTI

Fungi Imperfecti The fungi of this group do not show any sexual spore i e the life cycle is incomplete or better called incompletely known The sexual life of these fungi has not been discovered and they are therefore called Fungi Imperfecti In the words of Dodge The Fungi Imperfecti are conceived as a dumping ground until the gaps in our knowledge have fulfilled In the asexual life they appear similar to Ascomycetes and atleast some of them have been found to produce ascospores under special conditions of growth In such a case the fungus should be classified as Ascomycetes when it would show formation of asci These fungi are therefore classified on the basis of asexual spores or conidia which are relatively specific for a particular group of organisms The spores may be hyaline or coloured unicellular or multicellular The wall of the spore may be smooth or rough thin or thick According to the system of Saccardo (1884) Fungi Imperfecti are divided into three orders as follows

Conidiophores form acervuli in the substrate *MELANCHONIALES*

Conidiophores form cupshaped receptacles called pycnidia *SPHAEROPSIDALES* (Phomales)

Conidiophores free and do not form fruit bodies *HYPHOMYCETALES* (Moniliales)

Fungi producing diseases belong to the last group i e Hyphomycetales and a medical mycologist is specially interested in this particular group of fungi Moniliales or Hyphomycetales have been further divided into the following families

(1) Moniliaceae or Mucedinaceae—conidiophores and conidia are hyaline and bright in colour

(2) Dematiaceae—conidiophores and conidia are dark but conidia may sometimes be hyaline on dark conidiophores

(3) Stilbaceae—conidiophores are fasciculate parallel and form corremia

(4) Tuberculariaceae—Conidiophores form a globous sessile body called sporodochium Another may be added to the abov

(5) Mycelia sterilia—the members of this group do not produce any characteristic spore

Fungi imperfecti that are of medical intrest belong to two families viz Moniliaceae and Dematiaceae (dark spores) of the order Moniliales Further classification of Saccardo is based on the character of spores whether the spores are one celled or two celled or whether the spores show cross septa or both longitudinal or cross septa (muriform) For a medical mycologist it is convenient to classify Fungi Imperfecti according to the classification of Vuillemin instead of one followed by Saccardo Vuillemin (1910) divided Fungi Imperfecti into three orders on the basis of character of the spores and the fourth order Microsiphonales was later included (1912) According to a later classification by him (1925) the order Microsiphonales (Actinomycetes) was included as a family But according to the classification of Bergey (1948) Microsiphonales have been included in the order Actinomycetales under Schizomycetes Vuillemin divided asexual spores into two main divisions namely thallospores and conidia Conidia may be conidia vera and

aleuriospores Conidia vera are subdivided according to whether they are borne on sterigma or on well defined conidiophores The conidiophores have further been differentiated into phialides The spores borne on phialides have been called phialospores He also recognised Hemispores which structurally occupy a position between arthrospores and true conidia Aleuriospores were differentiated from true conidia by the fact that unlike true conidia they are not set free when mature but are liberated only after disintegration of mycelia These are also called microconidia and differentiated from septate macroconidia which are larger and pluriseptate American workers are in favour of calling aleuriospores as conidia but it is better to call them aleuriospores (microconidia) and differentiate them from conidia (conidia vera) according to the original classification of Vuillemin so that one could be distinguished from the other Spores arising from thallospores have already been described The classification of Fungi Imperfecti on the basis of Vuillemin s classification (1925) is as follows

CLASSIFICATION OF FUNGI IMPERFECTI

(After Vuillemin modified)

Order Thallosporales reproducing by thallospores

Suborder *Blastosporineae* reproducing by blastospores This includes nonsporing yeasts like cryptococcus (torula) Budding mycelia of the form of pseudomycelia are seen in the genus Candida

Suborder *Arthrosporineae* reproducing by arthrospores e g *Geotrichum candidum* Trichosporium Madurella Indiella

Family *Mycodermaceae*—with usual septate mycelia showing elongated budding forms

Order Hemisporales reproducing by hemispores Genus Hemispora *H stellata*

Order Conidiosporales reproducing by conidia

Suborder *Aleuriosporineae* reproducing by aleuriospores Ringworm fungi according to Ota and Langeron (1923) fall in this group

Suborder *Sporotrichineae* reproducing by conidia but conidiophores are absent e g Sporotrichum S *Schenckii*

Suborder *Sporophorineae* reproducing by true conidia borne on sporophore Most of the common mould of the class Fungi Imperfecti belong to this group

Suborder *Phialidineae* reproducing by true conidia borne on phialides —(flask shaped sterigma) e g Aspergillus Penicillium etc But some of these have been found to reproduce by ascospore and in that case they should be classified under the class Ascomycete

NOMENCLATURE

Under the plant kingdom there are phyla. Each phylum is subdivided in a descending order into classes, orders, suborders, families, tribes, genera and species. Species has often been subdivided into varieties when one species differs sufficiently from another. It is very important to note that orders end in *ales*, suborders in *ineae*, families in *aceae*, subfamilies in *oideae*, tribes in *eae* and subtribes in *inae*.

The name consists of two parts, i.e. the generic part which is a Latin substantive and always written with a capital letter, the second part is the specific name of the fungus which is usually adjective and is not written with capital letter, e.g. *Penicillium purpurogenum*. In this *Penicillium* is the generic name and expresses broom-like appearance but the specific name purpurogenum indicates a pigment which is purple in colour. Let us take another example—*Aspergillus flavus*. The word *Aspergillus* is the generic name. It is so named due to the resemblance of its spore heads to a aspergillum which is a kind of mop used for distributing holy water (Latin Aspergere=sprinkle). flavus indicates the yellow colour of the organism. The species is also named after the name of the discoverer e.g. *Trichophyton schoenleini*. In these some are inclined to put the discoverer's name with an initial capital letter. While citing the name of a species the name of the author who described it originally is often appended to the name of the species. But the name of the author is not written in italics. When the name is amended and a second name is introduced, the name of the original discoverer is put within brackets, e.g. *Trichophyton mentagrophytes*. It is amended from the name *Microsporum mentagrophytes* C. Robin 1833 and expressed as *Trichophyton mentagrophytes* (C. Robin) Blanchard 1896. Those who are specially interested in nomenclature are referred to International Rules of Botanical Nomenclature.

REFFRENCES

Bergey's Manual of Determinative Bacteriology by R S Breed, E G D Murray and A P Hitchens Sixth Edition 1948 William & Wilkins Co Baltimore

Vuillemin P Materiaux pour une classification rationelle des Fungi Imperfecti *Compt Rend Acad Sci* **150** 882 1910

Vuillemin P Les Champignons Essai de classification O Doin et Fils Paris p 236 1912

Vuillemin P Classification normale classement auxiliaire et groupement pratique des champignons *Comp Rend Acad Sci* **180** 102 1925

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CHAPTER II

MYCOSES

Terminology Diseases caused by fungi are called mycoses (sing mycosis) The terminology used for classification is based on the site affected or the fungus which produces the disease

(1) Anatomical terminology is used according to the site involved by the fungus viz dermatomycosis onychomycosis otomycosis pulmonary mycosis etc This terminology is convenient to use when a group of fungi is concerned to produce the disease

(2) A mycological terminology which is also useful is based on the name of the fungus that causes the lesion e g actinomycosis moniliasis sporotrichosis trichophytosis epidermophytosis etc In certain cases however it is convenient to use a combination of the above two viz broncho moniliasis pulmonary aspergillosis etc

Classification Human mycoses may be divided into three groups according to the tissue involved

(a) SUPERFICIAL MYCOSES These are caused by epiphytes or ectoparasites which may affect the deeper layers of the epidermis and set up inflammatory reactions Ringworm which affects the surface of the skin or its appendages like hair or nail is a typical example of such a mycosis In other instances epiphytes grow on the keratinised surface of the skin and often produce patchy macular lesions with discolorations of the skin without any tissue reaction e g pityriasis versicolor A fungus may produce slight excoriation of the keratinised layer of the skin often due to sweating e g erythrasma Other instances of superficial mycoses are piedra trichomycosis and otomycosis

(b) SUBCUTANEOUS MYCOSES In these granulomas are limited to the subcutaneous tissues and produced as a result of tissue reaction to fungi The lesions rarely spread via lymphatics or blood e g actinomycosis mycetoma chromoblastomycosis sporotrichosis rhinosporidiosis

(c) SYSTEMIC MYCOSES In these the causative fungi multiply in various internal organs and produce infectious granulomas Diseases of this group are North and South American blastomycoses coccidiomycosis cryptococcosis histoplasmosis moniliasis etc Rarely sporotrichosis may involve the internal organs and some are inclined to include it under systemic mycoses as the lesions spread through lymphatics Many fungi causing systemic mycoses may produce primary lesions in the skin and secondary lesions in the internal organs and *vice versa*

The classification of mycoses is not yet satisfactory as some would like to accept an arbitrary clinical classification as mentioned above in absence of a natural systemic classification The main difficulty in the clinical classification is the plurality of the parasite for a particular clinical condition and polymorphism

of the lesion produced by a fungus in different tissues It is difficult indeed at this stage to give a clear cut list of mycoses in relation to the tissue involved A natural classification on the basis of systemic position of fungi would have been an ideal one but the difficulty in that is that the systemic position of some of the pathogenic fungi like *Rhinosporidium seeberi* or *Coccidioides immitis* have not yet been determined Again fungi of the same systemic group may produce lesions widely variable from one another In this book diseases are arranged as far as possible on the basis of natural classification with the full knowledge of its drawbacks and difficulties

Epidemiology—The epidemiological factors of internal mycoses are still unexplored Recently light has been thrown on the subject of systemic mycoses especially in relation to their epidemiological aspects In this connection it should be mentioned that systemic mycoses are specially limited to certain areas of the world with their peculiar materiological and other environmental conditions Gilchrist s blastomycosis is peculiar to North America but only a few cases have been reported from Canada and England although stray unauthenticated cases have been reported from India and other parts of the world Paracoccidioidosis is particularly limited to South America Coccidiomycosis is a disease of southern parts of United States

Dimorphism Dimorphism is a feature peculiar to fungi of many systemic mycoses In many of these the fungus shows a morphological adaptation to a simple unicellular yeast form suitable for rapid reproduction and invasion of the human tissue but in artificial cultures in Sabouraud s glucose agar at room temperature they show mycelial forms with formation of conidia When the cultures are grown on blood agar at 37 C yeast forms appear as in the human body

The dimorphic characters of the fungi are shown below —

Organism	Disease	Yeast form in blood agar at 37 C	Mycelia in Sabouraud s glucose agar at room temperature
Blastomyces dermatitidis	Blastomycosis	+	+
B brasiliensis	Paracoccidioidal granuloma	+	+
Sporotrichum schenckii	*Sporotrichosis*	+	+
Histoplasma capsulatum	Histoplasmosis	+	+
Coccidioides immitis	Coccidiomycosis	Not seen	+

+ = Present

Sources of Infection Fungus infection often occurs from extraneous sources particulaly from the environment e g wood soil etc Incidence of Madura foot has often been found as a result of trauma caused by splinters of wood or as a result of thorn prick

Sporotrichosis is often seen in gardeners and wood-cutters The parasite *Sporotrichum schenckii* has been found as a saprophyte in various vegetable substrates nests of insects hide of horses which suffered from naturally acquired sporotrichosis Du Toit (1942) observed in South Africa that the fungus has a saprophytic existence in timbers in mines and infection was contracted by mine workers from infected wood

Chromoblastomycosis is caused by *Phialophora verrucosa Hormodendrum pedrosoi* and *H compactum* Conant (1937) observed that *P verrucosa (Cadophora americana)* occurs as saprophytes in decaying wood *H pedrosoi* has close resemblance with saprophytic species of Cladosporium present in the soil It therefore leaves little doubt that this infection occurs as a result of contamination of the skin by soil or decaying vegetations after a trauma

Blastomyces dermatitidis has been observed to grow saprophytically in the timber of North America and the pulmonary infection occurs in the majority of the cases by inhalation of spores from the saprophytic sources but in other cases inoculation of the fungus into the skin produces skin lesions

Cryptococcus neoformans the causative organism of cryptococcosis has been found in milk products and other food stuffs The infection in these cases has been suggested to occur through the oral mucous membrane or the skin According to Benham exogenous cryptococcus differs from the endogenous one which is responsible for producing cryptococcosis

Reservior Coccidiomycosis is highly infectious and common in its mild primary stage in the desert areas of South Western States of North America It has been shown by the recent work that rodents harbour the infection They act as animal reservior of the disease and the desert soil is contaminated by the reservior hosts The spores of the fungus when carried by the wind are inhaled by man causing primary coccidiomycosis of the lung The infection is rarely acquired through the skin

Histoplasma capsulatum often produces systemic mycosis It also affects the skin producing skin lesions It is a naturally acquired disease in man and dogs but there is no definite evidence as yet to say that the dog is the reservior host

Host Specificity Ringworm of the hair namely microsporosis and endothrix trichophytosis are specially limited to children and the disease is spontaneously cured at the attainment of puberty although there are instances in which endothrix trichophyton was seen to persist in some cases after the age of puberty Infection with *Microsporum audouini* has not yet been seen in an Indian child although it is quite a common incidence in Anglo Indian and European children in India *Trichophyton violaceum* infection which is common in India is seen in Mohammedan children and no case has been seen as yet amongst Hindus

Microsporosis and some cases of endothrix trichophytosis are se terminating and the disease often disappears at the advent of puberty This ha been explained by some authors due to changes of the hair brought abo by the endocrine secretion at puberty and this makes the hair resistant to thos infections Epidermophytosis is a common disease at the advent of puberty but it is rare in childhood *Microsporum canis* causes infection of cats an dogs and human subjects (both children and adults) get the infection whic produces intense inflammatory reaction causing a condition of kerion

Endothrix trichophyta viz *T violaceum T tonsurans* etc are pathogen to children and the infection spreads from one child to another *T discoides* a pathogen of cattle whereas *T mentagrophytes* (granular) is a pathogen horses and animals It may also infect man causing tinea barbae or tine capitis A variety of the same fungus is seen well adapted in cases of interdigit ringworm viz *T interdigitale* but they often produce inflammatory lesion like blisters on the insteps of the foot On the other hand the same fungus ma show a fairly moderate degree of adaptation to human hosts In such a cas the infection may persist in the skin without any inflammatory change b with recrudescence of the disease under favourable conditions of moistu and temperature

Relation of host to parasite The fungi that are well adapted to ma viz *M audouini* may cause spread of ringworm in an epidemic form boarding schools but *M canis* an animal parasite is ill adapted to huma hosts and reaction of the host is very severe as shown by a process of inflam matory reaction producing a condition of kerion

Histopathology This is studied in systemic mycosis where it essentially form an infectious granuloma In the immediate vicinity of the parasite there is deat of the tissue with abscess formation Many of these abscesses become surrounde by polymorphonuclear neutrophils and granulation tissue consisting of monon clear cells with giant cell formation and a dense layer of fibrous tissu The reaction however varies according to whether the lesion is a primary or secondary one In primary blastomycosis of the skin the lesion is essentially granuloma with gaint cell formation whereas a metastatic lesion often show abscess formation However in experimental infection in the laboratory th typ of l ion widely varies with the dosage mode of inoculation etc

Antibodies In bacterial infection circulating antibodes like agglutini precipitin and complement fixing antibodies form a marked feature but in mycose cellular reaction is characteristic and the antibodies which are often cel fixed are responsible for sensitisation of the individual and produce allerg reactions The cell wall of the fungus is thick and its intracellular protein hardl diffuses into the tissues The reactions are often due to liberation of substance owing to autolysis of the fungus The serological tests that might be positive fungus infections are agglutination precipitation aud complement fixation

Agglutination—Agglutination reaction has been performed in sporotrichos

schenckii from another Sera of sporotrichosis patients agglutinate spores of *S schenckii* in a high titre of 1 in 300 to 1 400 But it has the disadvantage in that the sera of thrush cases agglutinate spores of *S schenckii* even in a higher titre than they would do with the suspension of *Candida albicans* Sera of patients suffering from actinomycosis also agglutinate spores of *S schenckii* Agglutination reactions are really unsatisfactory for most of the mycoses

Precipitation—Precipitin has been detected in severe cases of coccidiomycosis but it is negative in mild cases This test is of little use in mycoses

Complement fixation The test was found to be positive by Widal et al (1910) in sporotrichosis but DuToit (1942) found this test to be unreliable Saline suspension of the yeast form of *B dermatitidis* as an antigen has been claimed to have given a positive complement fixation test with diluted sera in cases of North American blastomycosis and there is no cross reaction with other fungi But it is negative in mild and cutaneous cases even with undiluted sera Complement fixation test also becomes positive in cases with extensive lesions of Coccidiomycosis as in the cases of North American blastomycosis but the test has not been confirmed in cases of South American blastomycosis

Allergy and skin hypersensitivity Fungi have little invasive power as they often attack traumatised or keratinised tissues of the body To be invasive therefore the fungi should either increase in their virulence or there should be some environmental tissue changes Increase of virulence could not however be demonstrated in experimental inoculation in animals and therefore it is more likely that there is alteration in the tissue of the host

Local changes in infections are due to liberation of endotoxin which often causes destruction of the tissue resulting in extension of the lesion But more important changes produced by fungus infection are the altered reactivity of the tissue leading to allergy and skin hypersensitivity In this latter condition the fungus due to its continued existence at the site of primary infection sensitises the cells of the body and thus the host becomes susceptible to an accelerated tissue reaction In this state if the fungus or its product is introduced into the host an allergic recation is liable to occur with rapid spread of the disease In dermatophytosis the hypersensitiveness is noticed when the spores or mycelia enter the circulation from the site of primary infection This is characterised by the appearance of skin eruptions which are also known as id reaction Sensitisation is detected by various intradermal injections of extracts of fungi These cutireactions may become positive in cases with previous infection with the same fungus or an antigenically allied funeus So long as the cutireaction is positive it indicates presence of sensitisation But the antigen (allergen) in fungi is often of the nature of a group antigen rather than a specific one and this is the reason why an antigen which is common in more than one fungus may porduce a cross reaction Therefore a negative reaction is more important than a positive one The following skin reactions have been utilised in various fungus diseases

Trichophytin In experimental works in guineapigs it has been repeatedly demonstrated that sensitisation occurs only when a living culture of ringworm fungus is injected into the skin Injection of dead culture or the fungus extracts i e trichophytin does not provoke dermal sensitivity, nor injection of living culture in tissues other than skin produces this sensitivity The degree of sensitivity depends upon the species that infects the skin It is very much marked with animal species which cause deep seated lesions namely *T mentagrophytes* *T quinckaerum* and *M canis* The reaction is minimum with human species like *M audouini* *T tonsurans* and *T schoenleini* By the skin test and by sensitisation and quantitative desensitisation of the guineapig s uterus by Schultz Dale technique Jadassohn et al (1937) demonstrated that trichophytin contained a group antigen and some minor specific factors Therefore trichophytin test can not be considered as a specific but a group test This should not therefore form the sole basis of diagnosis

Various preparations of trichophytin are available and any of the standard preparations may be used for the test namely Metz 1 100 Lederle 1 30 or dermotrichophytin Muller and Phipps (India) Ltd It is difficult to standardise a home made trichophytin The reaction is judged by erythema and induration produced by the intradermal injection of trichophytin

VALUE OF THE TEST Trichophytin has been used diagnostically specially in suspected cases of id reactions and also therapeutically in deep seated ringworm infections The skin reaction becomes positive in the majority of deep seated ringworm infections After a considerable scrutiny of the results by various authors it has been concluded that negative reaction is of greater value to exclude an inflammatory lesion of *dermatophytic origin than a positive trichophytin test* If the lesion is of long duration the fungus cannot be detected microscopically and culturally and the trichophytin test is negative the inflammatory lesion may be declared not to be of dermatophytic origin

Coccidioidin Dr C E Smith prepared coccidioidin from strains of *Coccidiodes immitis* in a synthetic liquid medium In systemic involvement of coccidiomycosis marked skin hypersensitiveness develops The reaction is highly specific but a small number of persons who had no history of disease or contract or no history of residing in an endemic area were found to react to coccidioidin *This has not been explained as yet Therefore the negative test is valuable in the* diagnosis as it excludes the infection in cases other than those who are in the preallergic stage of the disease or in a state of anergy resulting from overwhelming infection In cases of systemic mycosis the test is useful epidmiologically to map out endemic areas

Blastomycin (Extracts of *B dermatitidis*) The test is specific According to Martin and others every patient suffering from active lesions of blastomycosis may not react to the skin test performed by the intrademal injection of blastomycin Mild cases with skin lesion often give negative results Normal people usually do not show the positive skin reaction Hypersensitiveness to it, as

determined by the skin test is a contraindication for iodide therapy. Cases of blastomycosis should be desensitised before they are treated with x ray or iodide.

Histoplasmin It is filtrate of synthetic broth culture of the fungus *H. capsulatum*. Histoplasmin has been used in epidemiological studies and found to be useful for detecting benign type of self limiting pulmonary histoplasmosis in endemic areas. Histoplasmin skin test becomes positive in the endemic areas of histoplasmosis in cases of non tuberculous pulmonary calcification. Cross sensitisation reactions may be noted for blastomycin and histoplasmin. Patients of coccidiomycosis often show a positive skin reaction to histoplasmin.

Sporotrichin Intracutaneous test with an extract of *S. schenckii* is useful when the test is positive, a negative result rules out the diagnosis of sporotrichosis. Occasionally only there may be a false positive reaction. According to Du Toit a positive reaction always occurs in cases of sporotrichosis. The appearance of sensitivity has been found to be on the fifth day after inoculation to a volunteer.

Oidiomycin This is a commercial vaccine prepared from *Candida albicans*. According to Lewis and Hopper skin sensitivity test with oidiomycin is of little value. Sensitisation of the skin is possible from a focus in the intestinal tract or from any other lesion which had subsequently resolved. He mentioned that of the 42 cases of cutaneous moniliasis a positive response was obtained in 57 per cent of cases. Again out of 91 patients with an infection due to a fungus other than *C. albicans* 45 per cent showed a positive reaction, whereas out of 192 patients without any evidence of fungus infection 46 per cent reacted to oidiomycin. *It can therefore be concluded that the test has little practical value in* the diagnosis of moniliasis.

Asthma Various spores of common moulds have been incriminated as etiological agents in asthma. These spores when inhaled with dust sensitise the subject and the sensitisation can be detected by cutireactions. Spores that might cause asthma are those of *Puccinia graminis* (wheat rust fungus), various species of Aspergillus, Alternaria and others. It has also been suggested that similar fungi might produce allergic eczema in those cases of asthma.

REFFRENCES

Conant, N. F. The occurence of a human pathogenic fungus as a saprophyte in nature. *Mycologia* 29, 597, 1937.

Du Toit, C. J. Sporotrichosis on the Witwatersrand. *Proc. Trans. Mine Med. Officer's Ass.* 22, June 1942.

Jadassohn, W., Schaaf and Wohler, G. Analyses of composite antigens by Schultz Dale Technique. Further Experimental analyses of Trichophytins. *J. Immunology* 32, 203, 1937.

An Introduction to Medical Mycology by G. M. Lewis and M. E. Hopper. Third Edition 1948. The Year Book Publishers Inc. Chicago.

Widal, F., Abrami, P., Brissaud, E. and Weill, A. Serodiagnostique Mycosique. *Ann. inst. Pasteur* 24, 1-33, 1910.

FUNGI PATHOGENIC TO MAN

TABLE II

Class	Or ler	Sul order	G nus	Species
Scl izomycetes (F on fungi)	\ tinomycetale		\ctinomyces Nocardia	*A bov* *N m d* *N k tol t* etc
Fungi Imperf ct	Tl allo poral s	Bl sto porineae	Crypto o cus P tyrosporum Bla tomyces Cocci l o le H st plasma Ph alophora Can l la Mala sezia	*C n f m s* *P or l* *B d m t t d* *B br l i* etc *(mm t* *H c ps lat m* *P u* et *C lb* *M f f*
		Blasto artl rospo n ae	G otricl um Tricl osporum	*G d d m* *T b g l*
		Artl osporineae	Ma lurella In liella	*M myc t m* etc *I m n* *I r* etc
	Hemi porale		Hemi pora	*H t ll ta*
	Con l o por l s	M uriospo inea	M cro p r m Epil mopl yton Tri l opl yton	*M d* etc *I fl m* *T t* *I s h l* et
			Gleno po a	*G g ph* *C s m n* etc
			\ ladium	*A t ll*
		Sporotr ch ne e	Spo otr l m	*S h k*
A omyc t	A p g ll les		Asp rg ll s	*A b ff d* *A f m t* *A n c* etc
			P n cill um	*P my t m*
			St r gmato yst	*S n d l*
			All l ia	*A b yd*
			I lraia	*P h t*
Pl ycomy etes	Mucorales		M or Rl pu et	*M mb f* *R y R n g*
Th xa t t xomom c posit on i not d t rm n d			Pl nospor d um	*R b s*

Som a e ncl ne l to ncl d th und Ph l l e e (Fungi Imp f ti)

STUDY OF PATHOGENIC FUNGI

Pathogenic fungi are studied under the following heads —

1. Direct microscopic examination
2. *Culture for isolation and study of giant colonies*
3. Microculture and hyphal fusion
4. Biochemical reactions
5. Filtered ultraviolet light (Wood's light)
6. Histopathology
7. Animal inoculation
8. Cutaneous tests (See Chapter II)
9. *Serological reactions (See Chapter II)*

Direct microscopic examination Direct microscopic examination of the *suspected material* is one of the most important methods available for investigation of fungus diseases Examinations of the hair scraping from the glabrous skin or nails show presence of the fungus in the ringworm lesion Any keratolytic solution which dissolves and clarifies hairs scales and nails may be utilised for this purpose Usually 10 or 40 per cent aqueous solution of potassium hydroxide is used as a keratolytic agent

Sodium sulphide is used by the author as a routine keratolytic agent* In a coverslip *preparation with this solution scales or hairs when heated for a minute* are quickly keratolysed in about 5 minutes but for nails it takes about 3 hours *to dissolve it completely This solution has the advantage over that of caustic* potash in that (i) it clarifies the cells without destroying the fungus (ii) it shows the fungus clearly and ringworm fungus may be spotted out under the low power and then confirmed by the high power

As an alternative method the fungus can be detected after staining with McGuire's stain* By this method the fungi are stained purple It is very easy to stain fungi by this method when they are present in the thin scales of tinea imbricata tinea versicolor and seborrhoea capitis

Another method is to treat scales nail scraping or hair in 5 to 10 per cent solution of caustic potash in a watch glass The material is then washed in water for a few minutes mounted on a slide under a cover slip in a drop of heated lactophenol with cotton blue *Hairs can also be mounted permanently*

Pus or other exudates Pus from an abscess exudate from an ulcer or sputum may be examined in the above way but they may be *examined* satisfactorily by a cover slip preparation with McGuire's stain This stains the fungus purple Granules in actinomycosis and nocardiosis are easily examined by crushing a granule in a drop of stain under the cover slip It stains the fungus beautifully and the leucocytes as well

Cerebrospinal fluid The cerebrospinal fluid is centrifuged and examined in any of the above methods or by fixing and staining smears with polychrome methylene blue or Leishman's stain Capsules of *Cryptococcus neoformans* can be well demonstrated by Indian ink in a cover slip preparation

* [illegible]

Culture Ringworm fungi may be detected under the microscope but for the identification of sp ci s the study of macroscopic and microscopic characters of the growth is nec sary Sabouraud s proof medium is used for primary culture and sub ultures As it is diffi ult to obtain the ingredients of the original formula different countries have modified the formula for this medium which gives a growth similar to one obtained in Sabouraud s proof m dium *

For isolation of fungus from grossly contaminated material (ringworm of the nail) it is better to use Sabouraud s proof medium containing 1 400 000 of gentian violet* The method is very satisfactory and secondary contamination is practically abs nt when this method is adopted Giant colonies are studied in Sabouraud s proof medium in Erlenmeyer flasks *

For isolation of fungi from cases of blastomycosis histoplasmosis and co cidiomycosis inoculate blood agar and glucose agar tubes and incubate them at 37 C but inoculate another set on Sabouraud s glucose agar and incubate hem at room temp rature For other media see appendix



F g 1a—W ll sl l



Fig 1b—Hollow groun l l le



Fig 1 —VanTiegh m c ll



F g 1d—M r ulture in well l l

Microculture For this hanging drop cultures are studied in well slides containing square slabs of stone about 2 5 cm square and 5 mm in thickness vith a central circular hole of 1 5 cm in diameter The slab is cemented on a microscopic slide (Fig 1a) The slide and the coverslip should be sterile The coverslip should b greese free Both can be wrapped in craft paper and autoclaved Sabouraud s semisolid agar (0 5 per cent agar) or any other suitable medium may be used for the study of the morphology of the fungus The agar is m lted in a boiling water bath and a drop of the medium is spread in the centre of the greese free coverslip with the help of a platinum loop As soon as the medium is cool the agar sets on the coverslip and a tiny bit of inoculum of the fungus to be studied is placed on agar The coverslip is turned upside down so that the inoculum is in the centre of the well hanging down from the coverslip (Fig 1d) The edge of the coverslip is quickly sealed with a mixture of hard and

soft paraffin in a proportion of 1 2 The mixture is melted and spread at the edge of the coverslip with the help of a camel hair brush The fungus grows in the medium and is studied for about 6 weeks Instead of media thick wheat or starch solution scales hair shavings from horn or hoops may be inoculated with the fungus with a drop of sterile water in the chamber Instead of well slides a hollow ground slide (Fig 1b) or a VanTieghem cell (*Fig 1c) can be used for the* same purpose The progress of the growth is studied from time to time for reproductive organs

Culture mounts are prepared from the hanging drop culture or by taking a bit of growth from agar The agar is teased separated from the growth and gently washed away The growth is then mounted in lactophenol—and sealed Another useful method is to spread a drop of melted agar under a coverslip The inocula from a culture are introduced on four sides of the coverslip The preparation is preserved in an improvised sterile, moist chamber From time to time the reproductive organs are studied When these reproductive organs are fully developed the coverslip is taken out and a culture mount is prepared

As an alternative method materials of dermatophytes could be inoculated on agar drops Dr Curry of Manchester University demonstrated a simple method for this purpose A sterile Petri dish is taken and on the inverted lid drops from a melted Sabouraud's agar tube dipped in a boiling water bath are dropped rapidly from a Pasteur pipette Drops are put at a distance of about one inch or so in rows and columns Agar drops solidify in no time These drops are then inoculated with the infective material after a preliminary treatment in alcohol for about five minutes About 20 inocula may be put in one plate Put a thin layer of sterile distilled water at the bottom of the Petri dish and put back the inoculated plate in position Thus the agar drops do not dry until water is exhausted by evaporation Water may be replenished if necessary from time to time The lid of the Petri dish can be everted placed on the stage of the microscope and examined for the reproductive organs

Hyphal fusion This was originally devised by Davidson et al (1932) In this *two inocula of the fungi to be studied are placed side* by side in a hanging drop culture in well slide without touching each other The fungus grows in the medium When they are allowed to grow mycelia of similar strains or same species only *fuse with each other but mycelia of different strains* or species do not show any hyphal fusion

Biochemical reactions Biochemical reactions are studied after isolation of organisms like *Candida albicans* and other *yeast like fungi* *Bacteriological* sugar tubes are used for this purpose Fermentation results are fairly constant for these organisms and thus may help in the determination of species Proteolytic activity of fungus is characterised by *liquefaction of coagulated serum gelatin or* peptonisation of milk

Filtered ultraviolet light This has been extensively used by American workers ... the fluorescence studied in lesions and in culture by using

ultraviolet light passing through Wood s filter This filter allows passage of ultravio et light of wave length of about 3650 A Certain fungi or infected materials show fluorescence in this light The method has been utilised for the detection of infection caused by *Microsporum audouini M gypseum* and *M canis* in the routine diagnosis of ringworm of the scalp The changes detected under Wood s light are mentioned in respective chapters

Histopathology Fungi that invade deeper tissues or internal organs show formation of granulomas often with giant cell formation The characteristic *lesions are dealt with in respective diseases*

Animal Inoculation Inoculation of mice w th infected material or culture is very important specially in cases of blastomycosis coccidiomycosis crypto coccosis and sporotrichosis This method should therefore be resorted to along with usual examinations namely direct microscopic examination and culture The method is also useful to isolate the organism in pure form from contaminated materials For inoculation susceptible animals like mouse rat rabbit or monkey may be used Again when an organism is isolated animal inoculation is useful for finding out the pathogenicity some of the saprophytes or contaminants can thus be excluded by adopting the method of animal inoculation

In ringworm infection when the fungus is isolated in culture animal ino ulations are undertaken as a routine measure for pathogenicity test This is done locally by shaving the skin on the back or abdomen and the suspension of the culture is applied on the part after scarification Fungi of animal sources usually produce lesions whereas the lesions produced by human species are spontaneously cured in about 10 days

REFERENCE

Da d on A M D wli g E S and B ll r A H P Hyphal fusion in lermatophytes *C d J R* 6 1 193



CHAPTER IV

ORDER ACTINOMYCETALES

The organisms of the order Actinomycetales occupy a position intermediate between bacteria and fungi. But according to the present conception they are considered as Schizomycetes (Bergey 1948). They are 1 μ or less in diameter and include Mycobacterium, Actinomyces and Nocardia, but unlike bacteria the organisms of the last two groups show branching. On the other hand in some actinomycetes mycelial filaments divide into fragments resembling bacillary (diphtheroid) and coccoid forms.

CLASSIFICATION (Waksman and Henrici 1943)

A. Mycelium rudimentary or absent. Family Mycobacteriaceae Chester.
I. Organisms acid fast. Genus *Mycobacterium* Lehmann and Neumann.

B. True mycelial forms showing branching.
I. Vegetative mycelium divides into fragments (bacillary or coccoid forms).
Family Actinomycetaceae Buchanan.

(a) Anaerobic or microaerophilic, parasitic, nonacid fast.
Genus *Actinomyces* Harz.

(b) Aerobic, partially acid fast or nonacid fast.
Genus *Nocardia* Trevisan.

II. Vegetative mycelium does not divide into bacillary or coccoid fragments.
Family Streptomycetaceae Waksman and Henrici.

(a) Aerial hyphae form conidia in chains.
Genus *Streptomyces* Waksman and Henrici.

(b) Aerial hyphae show terminal spores on short sporophores.
Genus *Micromonospora* Ørskov.

TABLE III. TABLE SHOWING PATHOGENIC SPECIES OF ACTINOMYCES AND NOCARDIA

Organism	Disease	Distribution
ANAEROBIC *Actinomyces bovis*	Actinomycosis in man and cattle	Cosmopolitan, chiefly in U.S.A.
AEROBIC *Nocardia madurae* and allied organisms	Mycetoma	India, Egypt and a few from U.S.A.
N. asteroides (*N. gypsoides*)	Pseudotuberculosis and deep-seated abscesses	Cosmopolitan
N. keratolytica	Superficial keratolytic lesions of the skin	India
N. minutissima	Erythrasma	Cosmopolitan, specially in the tropics
N. tenuis	Nodosities of the hair	Cosmopolitan, specially in the tropics

[illegible]

ACTINOMYCES BOVIS Harz 1877

Synonyms *Actinomyces isreali* Dodge 1935 *Disconyces bovis* Rivolta 1878 *Nocardia actinomyces* Trevisan 1899

History Ray fungus was first demonstrated by Von Langenbeck (1845) in a case of Pott s disease in a young man Similar organism was reported by Lebert (1846) and Davaine (1859) Sulphur granules were described by Rivolta (1868) in actinomycotic lesions of cattle and the causative organism was called *Disconyces bovis* The disease in cattle was described by Bollinger (1877) and he called it actinomycosis, Harz in the same year named the organism of lumpy jaw *Actinomyces bovis* Isreal (1878) identified lumpy jaw of cattle with human actinomycosis and Wolff and Isreal (1891) cultivated it for the first time and established its pathogenicity

Habitat *A bovis* is naturally found in teeth gum and tonsils of man and in actinomycosis of the jaw lungs and intestine In cattle sheep and pig it causes lumpy jaw (Pl II Fig 1) They are strict parasites and not found in nature apart from the parasitic habitat

Morphology It is a nonmotile nonsporing non acidfast Gram positive filamentous organism with branching (Pl II Fig 2) The filamentous mycelia are 1μ or less in diameter They show bacillary forms after fragmentation In tissues the organism forms granules which show tangled mass of mycelia and at the periphery of the granules filaments show terminal swellings specially marked in cattle assuming a characterestic club like appearance The ray like arrangement is due to the clubs Clubbed mycelia are Gram negative and the tangled mycelia are Gram positive On staining the tissue section the filaments are stained with haematoxylin and margin of the clubs with eosin

Cultural characters *A bovis* grows under anaerobic or microaerophilic condition In primary culture the growth is poor and slow It grows in ordinary media but the growth is better in media containing blood serum or glucose Brain heart infusion agar (Bacto) is useful for plating Subculture is easy to grow No pigment is formed Rough and smooth forms are recognised the latter are recovered directly from the oral cavity or from actinomycosis of animals Optimum pH is 7 2 to 7 6 and the optimum temperature for growth is 37 C

In glucose agar *Shake culture* the maximum growth is found at a depth of 1 to 2 cm below the surface in a zone where there is only a trace of oxygen and optimal concentration of carbon dioxide proving that it is microaerophilic (Pl II Fig 3) In *solid media* the colonies are raised nodular cream coloured opaque heaped up about 2mm in diameter and show a rosette form irregular in outline and firmly adherent to the medium (Pl II Fig 4 4a) In *liquid media* growth occurs as fuzzy colonies after incubation for several days Organisms from culture show short bent branching filaments with V or Y forms often with swollen ends

Biochemical reactions Several sugars are fermented including glucose and lactose with production of acid only but these reactions are of little diagnostic value Most of the strains are not proteolytic do not liquefy gelatin or form

indole These are non haemolytic and do not reduce nitrates Litmus milk is unchanged

Resistance It is killed at 60 C in one hour and susceptible to disinfectants It is difficult to maintain the stock cultures but they may remain alive for several months when kept dried in vacuum Sulphonamides and penicillin are active *in vitro* and are responsible for cure of about 50 per cent of cases

Antigenic structure Strains of *A bovis* isolated from lesions in man and animals and from the normal mucous membrane show wide range of variation in morphology biochemical reactions etc Serologically they are heterogeneous but their differences do not justify to establish separate new *species* The pathogenic organisms are classified as one species i e *A bovis*

Animal inoculation It is pathogenic when inoculated into rabbits and guineapigs producing typical granulomatous lesions containing granules *A hominis* (Bostroem) which is a saprophyte grows aerobically and fails to produce any lesion by animal inoculation

ACTINOMYCOSIS

This is a chronic infective granuloma caused by *A bovis* characterised by formation of nodules which spontaneously ulcerate form sinuses and discharge pus containing typical sulphur granules It primarily affects the jaw lungs or intestine but may spread haematogenously to other parts of the body

Signs and symptoms The incubation period is not definitely known but it varies from a few days to a few weeks The lesions are generally painless The disease starts as a firm purplish nodule which gradually enlarges softens to form an abscess The abscess bursts forms a sinus from which sulphur granules are discharged The disease spreads by contiguity and the surrounding areas become studed with nodules The affected area has board like resistance on palpation and shows multiple openings containing granules and sero purulent fluid These multiple openings are due to formation of intractable sinuses The underlying bone may be involved in the process The spread of the disease does not occur through the lymphatics and this is how it differes from other granulomas Metastasis may take place in the liver brain kidney or lungs by haematogenous route The breast or ribs may be involved as a process of extension from the lungs

It is customary to classify actinomycosis into cervicofacial thoracic abdominal and skin types accoding to the site of involvement

Cervicofacial actinomycosis is the commonest type (Pl II Fig 5) It accounts for 50 per cent cases The route of infection is the mucous membrance of the mouth and frequently it starts from a carious tooth or tonsil From the site of primary lesion it spread to the deeper tissues and ultimately to the skin of the face and neck or to the tongue and involve the neighbouring structure Maxillary bone vertebrae or orbit may be secondarily involved

Plate II



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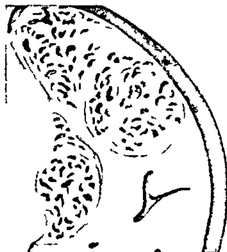
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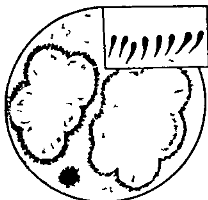
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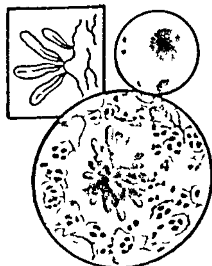
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To fa p

Thoracic actinomycosis accounts for 15 per cent of cases It originates from the mouth or throat by aspiration of the infective material or as an extension from the abdomen or as metastasis The lesion is mainly found in the lung where small abscess cavities are formed Extensive lesions may be seen involving bronchi and their rupture may cause dissemination through the bronchogenous route From the lung the lesion may spread to pleura pericardium heart or chest wall by a process of direct extension

Abdominal actinomycosis accounts for 20 per cent of cases It is commonly seen in the caecum and appendix The abdominal infection is probably derived through the intestinal mucous membrane which may not be involved Suppurating foci may be adherent to the abdominal wall by a process of fibrosis involving the skin The liver is commonly involved by a process of metastasis or extension (Pl II Fig 6) and extension of the lesion to the genital tract and kidney is relatively frequent (Pl II Fig 7)

Skin actinomycosis accounts for 15 per cent of cases It is difficult to say whether skin is primarily affected in every case as actinomycosis of the skin secondary to lesions of the underlying tissue or organ is rather common

Pathology In the tissue the organism forms granules which are discharged in the pus When these granules are crushed and examined with McGuire stain they are seen to be composed of tangled mass of mycelial filaments forming club at the terminal end These are arranged in a radiating manner and hence the name ray fungus (Pl II Fig 8) Clubs are well formed in the lumpy jaw of cattle but not in human actinomycosis The granules are embedded in pus containing polymorphonuclear neutrophils (Pl II Fig 9) Around the mycelial mass granulation tissue is formed with formation of giant cells and proliferation of fibroblasts Fat laden macrophages are present in the peripheral portion of the abscess and this may give yellow colouration of the lesion visible even to the naked eye

Diagnosis The clinical diagnosis should always be confirmed by microscopical examination of the granule Granules are crushed and examined under a coverslip preparation with a drop of McGuire's stain They show ray fungus i e filaments with ray like arrangements The isolation and identification of the organism can only be made by culture which should be done both aerobically and anaerobically For this granules are washed repeatedly in saline treated with alcohol for 5 minutes and crushed into small bits The tiny bits are then inoculated in 1 per cent glucose agar shake culture tubes Several tubes should be inoculated and incubated at 37 C anaerobically for about a week Mulberry like colonies about 2 or 3 mm in diameter appear in the depth of the agar A dense zone of growth is seen about 2 cm below the surface Bacto brain heart infusion medium with 2 per cent agar may be

Plate II Fig (1) Lumpy jaw in cattle ( ) Branching of mycelium of *A b* (3) Shake culture of *A bovis* in glucose agar (4 4) Anaerobic culture of *A b* on glucose agar showing mulberry character ( ) Section of abdominal actinomycosis (6) actinomycosis of liver ( ) actinomycosis of kidney (8) Ray fungus (inset—high power—showing clubs) (9) granule with infiltration surrounded by polymorphonuclear neutrophils

used for culture under anaerobic condition. Once the anaerobic growth has appeared, subcultures may be maintained aerobically in a suitable *medium*. Serological and cutaneous tests have proved to be unsuccessful.

X-ray diagnosis. In the early stage of the disease the skiagram of the jaw does not show any involvement of the bone but later there may be periostitis or true osteomyelitis with *destruction of the bone*.

Treatment. In the early stage when there is no involvement of the deeper tissue, *excision of the nodule may be possible*. In the later stage of the disease all the sinuses should be opened up, scraped and drained. Liq. iodi mitis can be *used locally* as an antiseptic. Potassium iodide should be administered intravenously or by mouth in massive doses. Initially 10 c.c. of 10 per cent solution can be administered intravenously and the dose is gradually increased upto the extreme limit of tolerance of the patient. When the lesion is not accessible, X-ray therapy has given good results in semi-intensive doses with filters. The treatment should be repeated for 3 to 4 weeks. In systemic infection deep therapy is indicated.

Penicillin should be administered intramuscularly in doses of 40,000 units every three hours to a total dose of 6,000,000 units. It should be noted that *different strains vary in their sensitivity to penicillin in vitro*.

Sulphonamides have been administered with good results. Sulphadiazine is administered in doses of 4 to 6 gm. per day and the dose is reduced to 2 gm. per day after clinical improvement of the patient. The results are however inconsistent with this treatment. X-ray, penicillin and sulphonamide treatment may however be combined with advantage.

NOCARDIA

Unlike Actinomyces, Nocardia are free living aerobic organism found in soil and as *contaminants from soil sources*.

History. Nocard (1883) first described an organism in cattle called *Nocardia farcinica* by *Trevisan (1889)*. *Eppinger (1890)* described N. (*Cladothrix*) *asteroides* isolated from a case of human pseudotuberculosis with meningitis and brain abscess. Vincent reported *N. (Streptothrix) madurae* (1894) which he cultivated from a case of mycetoma of the foot. Blanchard (1896) put the last two in the genus Nocardia. Since these reports many *more species were included* in the genus Nocardia.

Morphology. These are Gram positive filamentous organisms 1μ *or less* in diameter with branching. Some of them are acidfast (*N. asteroides*) and may be mistaken for tubercle bacilli. In addition to the *filamentous forms*, bacillary and coccoid forms are seen in certain species. In the tissue they form granules, yellowish white, red or orange in colour with tangled mycelia with or without club formation at the periphery. Bacillary form may be seen in the exudates of body fluids like cerebrospinal fluid, sputum, empyemic fluid.

Culture. These are aerobic organisms and grow at room temperature and at 37°C on simple media e.g. glucose agar, Sabouraud's glucose agar, Czapek's

synthetic agar etc Initially colonies are small and grow slowly and a typical appearance is seen in six weeks Cultures vary in gross appearance and pigment formation according to the media They are glabrous wrinkled or cerebriform and the surface is granular or mammillated and closely resemble the growth of acidfast bacilli The growth may be soft moist and mucilagenous or hard dry and granular Aerial mycelia which are characteristic of Streptomyces are not usually seen The colour of the growth may be yellowish ochraceous pink red or orange

Biochemical Biochemical reactions are fairly constant Some Nocardia are proteolytic liquefy gelatin and coagulate milk They do not ferment carbohydrate or produce indole H_2S or NH_3 The species are differentiated on the basis of coagulation of milk reduction of nitrates to nitrites power of liquefying gelatin acidfastness and pigment formation

TABLE IV TABLE SHOWING DIFFERENCE OF COMMON NOCARDIA

Name of species	Granules in lesion	Pigment on Czapek s medium	Growth on Sabouraud s glucose agar	Acid fast	Gelatin liquefac tion	Coagula tion of milk
N asteroides	Yellowish white	Yellow to ochraceous orange or red	Wrinkled granular	+	—	—
N brasilien sis	Yellowish white	Yellow to ochraceous or orange	Often chalky growth cere briform dry or tenacious earthy odour	+	+	+
M madurae	Yellowish white	Cream to pink or red	Moist soft wrinkled	—	+	+
N Pelletieri	Red	Coral red	Glab ous wrinkled moist	—	+	+

N B — nd cate neg tive and + ind cates positi e r sult

Resistance All these are soil organisms and have marked resistance to desiccation They are readily killed at 60 C for one hour *N asteroides* is resistant to streptomycin and penicillin

Pathogenicity Inoculations of *N madurae* is not pathogenic to laboratory animals *N asteroides* is the only species of the group pathogenic to laboratory animals but strains vary greatly in their power to produce lesions Death of the guinea pig results after an intraperitoneal injection of a large dose of the organism but a smaller dose injected intravenously causes death of the rabbit producing miliary abscesses Intramuscular or subcutaneous injection produces local lesion with abscess formation which ruptures spontaneously and becomes cured

SOME PATHOGENIC SPECIES OF NOCARDIA

NOCARDIA MADURAE (Vincent) Blanchard 1896

Synonyms *Nocardia indica* Kanthack 1893 *Steptothrix madurae* Vincent 1894

The organism is found in the granules of mycetoma and is commonly seen in Asian and African countries The grains are yellowish white in colour

Morphology The granules are composed of thin mycelial filaments with a few or no claviform swellings at the periphery Some mycelia show chains of small conidia at their extremities The organism is not acidfast

Culture *N madurae* is an aerobe and grows in ordinary media The growth occurs at room temperature and at 37 C In *liquid media* it grows as tiny granular puff balls which rest at the bottom of the media The supernatant fluid remains clear when there is no contamination In *solid media* like Sabouraud's glucose agar raised colonies are seen giving an irregular mammillated surface and a pink colour often develops which gradually becomes red (Pl III Fig 1) The size of the *colony* is about 1 5 cm after six weeks *Old cultures* show fragmentation of hyphae which serve as reproductive structures

Animal inoculation Animal inoculation shows negative result and inoculation *to rabbits may cause only a temporary local lesion*

NOCARDIA ASTEROIDES (Eppinger) Blanchard 1896

N asteroides produces mycetoma pulmonary lesions (pseudotuberculosis) abscess of the brain and meningitis The grains are yellowish white in colour They are antigenically related to *Myco tuberculosis* They are very fragile and easily dissociate when they show bacillary forms They are acidfast and resemble *Myco tuberculosis* but unlike *Myco tuberculosis* they grow faster

It is an obligatory aerobe and grows quickly on ordinary laboratory media at room temperature and at 37 C On Sabouraud's glucose agar the colonies are glabrous folded and the colour varies from pale yellow to deep orange On microscopic examination the colonies are seen to consist of tangled delicate *branching hyphae* bacillary form is also seen It can be readily differentiated from *Myco tuberculosis* by culture and guinea-pig inoculation

NOCARDIA BRASILIENSIS (Lindenberg) Castellani & Chalmers 1913

It is synonymous with *N mexicana* which has been reported to produce mycetoma in Mexico

N brasiliensis produces pulmonary lesions which may spread to other part of the body The granules are yellowish white in colour Hyphae are thin delicate and fragile They are Gram positive and acidfast Growth on Sabouraud medium are often chalky cerebriform dry or tenacious with an earthy odour The clinical picture is indistinguishable from those of *A bovis*

NOCARDIA PELLETIERI (Laveran) Pinoy 1912

N pelletieri cause mycetoma with red granules with or without club formation The hyphae are thin delicate They show a glabrous wrinkled coral red growths Fragmentation of hyphae is not usually seen They are Gram positive but non acidfast They liquefy gelatin and coagulate milk

DISEASES PRODUCED BY NOCARDIA

1 Mycetoma
2 Superficial nocardiosis of the skin
3 Erythrasma
4 Trichomycosis nodosa

MYCETOMA

History Mycetoma is commonly known as madura foot because of its high incidence in the district of Madura in Madras The condition has been known in India since ancient days and mentioned in Ayurveda as *Padavalmicum* a disease in which the foot is swollen and a kind of fleshy tumour develops like ant hill with discharge of peculiar fluid Colebrook (1844) of Madura clinic described the disease as Madura foot The fungus nature of the disease was first described by Vandyke Carter (1874) who clearly established it as a distinct clinical entity and named the disease mycetoma (fungus tumour) Vincent (1894) in North Africa succeeded in culturing the fungus from mycetoma of ochroid variety Pinoy (1913) used the term mycetoma to include two etiological groups namely true mycetoma caused by fungi having larger hyphae and actinomycotic mycetoma caused by Actinomyces and Nocardia Chalmers and Archibald (1916) accepted this classification and divided Mycetoma into two subgroups Actinomycoses and Maduromycoses (true mycetoma) It is therefore customary to divide mycetoma into these two etiological types and this classification has been generally accepted Gammel (1927) in a review of mycetoma mentioned thirteen species of Actinomyces of the actinomycotic group whereas in the Maduromycotic group he included 19 species belonging to two classes e g Fungi Imperfecti and Ascomycete each containing four genera Since then more fungi have been included in the list Under the circumstances the second subgroup is not tenable as it not only contains Madurella but also several unrelated species of different classes It is therefore better to retain the name mycetoma for both the type of infection without subdividing them

Etiology Mycetoma is a disease of the exposed parts of the body specially the feet although subcutaneous tissues of other parts of the body may be infected Most of these patients are found to walk bare footed and give history of injury such as bruise thorn prick or introduction of wood or other foreign materials into the skin

Organism A large number of organisms is responsible to produce the lesion These fungi form granules of different colours namely black white or yellowish white and red

Organisms with black granules— *Nocardia paraguayensis* Madurella Glenospora Aspergillus Penicillium Cephalosporium

Organism with white or yellowish white granules are mainly due to infections caused by fungi of the genus Indiella namely *I mansoni I reynieri* or *I brumpti* Fungi of this group belong to the class Fungi Imperfecti and have not yet been

cultivated *N madurae N brasiliensis* and *N asteroides* also produce similar granules Fungi of the Ascomytes group which produce white mycetoma are *Allescheria boydii* (Imperfect form is *Monosporium apiospermum*) *Sterigmatocystis nidulans*

Organisms with red granules—Nocardia pelletieri and Aspergillus species

Signs and symptoms The lesion appears after an incubation period of months and years It is characterised by pain and swelling of the part with multiple sinuses and spindle shaped deformity of the foot developing after several years (Fig 2) Granules of various sizes and different colours e g black white or red are discharged from these sinuses with sero purulent matter The infection spreads to the adjacent tissues forming nodules which soften and form abscesses which burst leaving multiple openings of sinuses In some cases there is destruction of the underlying bones The condition often remains localised without metastasis

Pathology The granules consist of a central mass of mycelial elements forming sclerotes These elements are arranged in a system having a central mass of mycelial threads or debris from which radiating hyphae show a palmate or fan like arrangement *Several of these may be arranged on a common base* in an imbricated concentric or mulberry fashion The size of the granules vary from 1 to 2 mm and individual granules often coalesce to form larger aggregations of several millimeters in diameter They may be soft and cheesy or hard and brittle Microscopically the grains consist of 3 zones *(a) central zone* of mycelial reticulum and pigment granules (b) intermediate zone consisting of irregularly amorphous and deeply pigmented substance (c) outer zone which is refractile and gives a typical palm leaf or ray like appearance



Fig —Mycetoma [illegible]

Histopathology In a histological section a granule is seen to consist of entangled mycelia embedded in a mass of polymorphonuclear neutrophils Surrounding this there is a layer of granulation tissue with giant cells infiltrating round cells and fat laden macrophages enclosed by a fibrous capsule

Cultures Cultures are obtained by inoculating blood agar plates which are incubated at 37 C Sabouraud s glucose agar slants are also inoculated and incubated at room temperature Anaerobic cultures are necessary in case of *A bovis*

Diagnosis Clinically multiple sinuses with tumefied foot is very characteristic Granules expressed from the sinuses can be crushed under a coverslip They show lobulated masses surrounded by pus cells The masses contain tangled mycelia which are fine in case of actinomyces and Nocardia infections clubs may be present in certain cases Gram stain shows short branching forms or coccoid elements which are Gram positive In Maduromycoses and other cases the granules are treated with sodium sulphide solution till they are soft When soft they can be pressed under the coverslip and spread into a thin layer to show fungi which are larger in dimension

Treatment Amputation of the foot is the only successful treatment owing to the fact that there is a high mortality rate in cases of Madura foot caused specially by Nocadia

SUPERFICIAL NOCARDIOSIS OF THE SKIN

[Caused by *Nocardia keratolytica* (Acton and McGuire) Dey 1957]

Definition This is a keratolytic condition of the hands and feet caused by *Nocardia keratolytica* characterised by keratolysis of the epidermis of the palms and soles and other lesions variously described as pitted sole mangoe toe cracked heel paronychia onychomycosis and vesicular eruptions

Etiology The disease is caused by *N keratolytica* enormously present on the damp and mannured soil containing organic matters The disease is common in cultivators and gardeners who often walk bare footed It is also common amongst housewives and maid servants who are in the habit of handling mud with their hands kept moist for a long time The disease is generally seen during the monsoon months in India It has also been found to occur in Europeans on coastal vessels of India as they have acquired the habit of walking bare footed on the deck

Mycology *Direct examination* Scraping from the margin of the pit sulci or top of the vesicle is soaked in normal saline to soften it teased and placed on a slide with a drop of McGuire s stain which is allowed to act for 2 to 5 minutes and then mopped off with a piece of filter paper It is then mounted with a drop of neutral glycerine under a coverslip A little pressure on the coverslip will flatten out the epidermis It is then examined with 1/12 oil immersion objective and X10 ocular The hyphae are seen to consist of fine segmented branching filaments The oldest hyphae are very closely segmented and give a beaded appearance like the chain of streptococci (Pl III fig 2) Conidia may be seen at the end of ome hyphae

Culture The diseased area is well washed with soap and water to remove all dirts and then swabbed with 75 per cent alcohol The tissue from the margin of the lesion is obtained and soaked for about 2 hours in normal saline to soften it The material is then teased with a pair of needles into small strips and treated with absolute alcohol for one minute and these strips are planted directly into the Norris medium at pH 7 4

Norris medium

Soluble starch	2 gm
Dipotassium phosphate	0 5 gm
Hydrated magnesium sulphate	0 2 gm
Calcium chloride	0 05 gm
Ferric chloride	0 01 gm
Sodium nitrite	0 05 gm
Asparagin	0 05 gm
Agar	20 0 gm
Water	1000 0 c c

Plates prepared from this medium are inoculated with small bits of infected tissue and incubated at a temperature of 25 to 35 C or room temperature This *synthetic medium inhibits the growth of most of the secondary organisms* In four days the primary culture shows small raised pink colonies (Pl III fig 3) The colonies become larger and deeper in colour with the age of the culture and still later develop into flat moist colonies with areas of darker or black tint In Sabouraud's *medium subcultures show the same character of growth* (Pl III figs 4 and 5) On blood agar the culture shows a zone of haemolysis

Biochemical reaction Sugar or glycerol is not fermented Milk becomes slightly acid and clotted

Morphology The hyphae are about 0 8 μ in diameter they are segmented branched and show conidia (1 to 1 5 μ in diameter) which may be single or in cluster some mycelia may have clubbed ends due to swelling of the end of the hyphae There are often intercalary chlamydospores with thickened walls

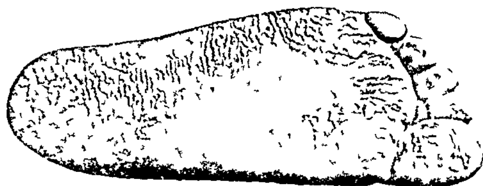


Fig 3—5 [illegible]

Signs and symptoms The disease is characterised by pitted appearance of the affected parts But as the disease persists cracking and exfoliation take place According to the type of the lesion several clinical types have been described by Acton and McGuire (1930 1931)

Clavum or sieve like pitted sole (Fig 3) shows small multiple pitted areas with moth eaten appearance (Pl IV Fig 6) They may show similar pitting on the palms of the hand (Pl IV Fig 7)

Plate III

COMMON PATHOGENIC NOCARDIA

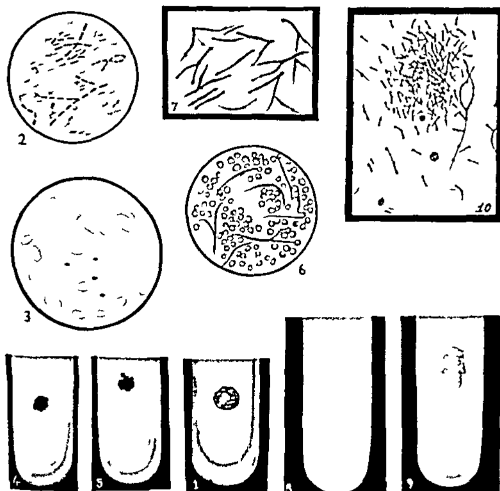


Fig (1) Growth of *Nocard a madurae* (Sabouraud s glucose agar)
F g (2) Skin scraping showing *Nocard a keratolytica* bacillary and coccal forms
Fig (3) Primary culture of *N Keratolytica* on Norris agar plate
Fig (4) Early colonies of *N keratolytica* (Sabouraud s glucose agar)
Fig (5) Old colonies of *N keratolytica* showing black colouration at the periphery
Fig (6) Mycelia and spores with terminal clubs in culture of *N keratolytica*
Fig (7) *Nocardia minutissima* in scales (McGuire s stain)
Figs (8) and (9) *Nocard a tenu s* in p re culture
Fig (10) *N tenu s* showing metachromatic granules and branching in places (McGuire s stain)

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Plate IV

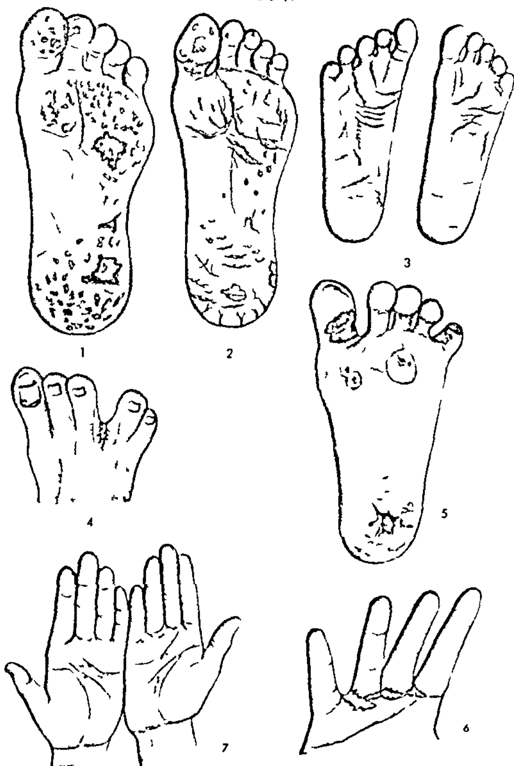


Fig. (1) Sole of th[illegible] foot showing [illegible]e-like appearance [illegible]
Fig. ( ) Cracks and fissures [illegible] at the margin of the foot and heel
Fig. (3) Hypertrophic lesions on the sole of the foot with [illegible]
Fig. (4) Sodd[illegible] condition in between the toes [illegible] and ulcer at th[illegible] of th[illegible] nail
Fig. (5) Deep ulcers [illegible] th[illegible] great and littl[illegible] toes as a result [illegible] of [illegible]
A deep area of [illegible] seen at the heel
Fig. ( ) Ulcer [illegible] the palm of th[illegible] hand as a result of extension of interrig[illegible]
Fig. ( ) Minut[illegible] pitting of the palms of th[illegible] hand [illegible]

T / ~ / [illegible]

Phata This is a condition of cracked heel and fissures appearing at the margin of the sole (Pl IV figs 2 and 3) Hyperkeratosis is often associated with it (Pl IV fig 3)

Haja or intertrigo (Pl IV Figs 4 5 and 6) is an interdigital affection of the webs of the toes and fingers The condition somewhat resembles mango toe caused by ringworm fungi (Pl IV Fig 4) The infection starts as an intertriginous lesion on the webs of fingers and toes and extends to the palmar or the plantar surfaces as gyrate areas of keratolysis (Pl IV Figs 5 and 6) The ulceration generally progresses to a considerable depth producing in some cases spontaneous amputation of the toe

Paronychia The fungus has been found to produce inflammation around the soft tissues of the nail of the hands and feet and sometimes the base of the nail is involved showing ulceration (Pl IV fig 4) The nail plate when affected may give a moth eaten or pitted appearance with darkening of the nail

Pompholyx Vesicles may appear on the palm instep or sole They leave pitted scars on the affected areas of palms (Pl IV fig 7) and soles

Differential diagnosis *Phata* or fissures at the margin of the foot and heel and *Chalum* or pitted sole are easily diagnosed by the typical appearance of the lesion

Haja (intertrigo) or interdigital erosion should be differentiated from those produced by ringworm fungi In the latter microscopic examination of scrapings should show numerous ringworm fungi under the high power objective When the examinations of scale is negative for ringworm fungi one should *consider* investigation for *N keratolytica* Interdigital affections of the webs of the fingers show a sodden worm eaten appearance which spreads on the *palm in the* contiguous parts The deep fissures of mango toe are more characteristic of *N keratolytica* infection than those of ringworm this is due *to the marked* keratolytic action of the fungus

Hypertrophic lesions of the palm and sole must be differentiated from tylosis keratodermia of palms and soles caused by syphilis and *yaws and* hyperkeratosis caused by ringworm Localised keratolysed areas caused by *N keratolytica* often simulate perforating ulcers of leprosy and it should be differentiated from the latter condition

Paronychia caused by *N keratolytica* should be differentiated from similar lesions produced by *Candida albicans* in the former *condition the base* of the nail shows keratolysis and pitting of the nails is often associated with interdigital affections but in the latter the margin of the nail shows *bolster like swelling*

Nails affected by *N keratolytica* are like those affected *by ringworm* fungi but in ringworm of the nail a positive finding of the ringworm fungus clinches the diagnosis whereas in the affection caused *N keratolytica* fine mycelia can be demonstrated with McGuire s stain under 1/12 *oil immersion* objective Pitting of the nail is found in this as well as in psoriasis therefore psoriasis must be excluded in these cases by exclusion of the lesion *in other parts of the body*

Prophylaxis The practice of walking bare footed should be avoided In the case of cultivators who are inevitably exposed to the infection the prophylactic application of Lotio formalin et glycerine* is advantageous

Treatment *For chalunt* The application of Lotio formalin et glycerine* is useful For other conditions a 2% solution of gentian violet in 10% alcohol is quite satisfactory Recently Lotio triple dye* has been used It is quite as effective as in mango toe and other interdigital affections In paronychia the lotion should be applied well inside the margin of the nail

ERYTHRASMA

[The causative organism is *Nocardia minutissima* (Buchardt) Verdun 1912]

Erythrasma is a superficial infection of the skin of the moist parts of the body viz , the axilla (Fig 4) groin fold of the breast and other intertriginous regions caused by *N minutissima* It is characterised by brawny desquamation with furfuraceous scales showing maceration and excoriation of the affected part The affected skin shows a serpiginous and erythematous margin It is common in the tropics and seen in obese people sweating profusely

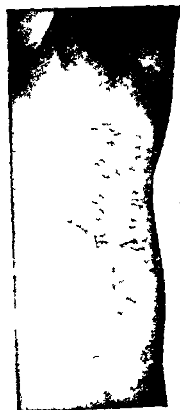


Fig 4—Erythrasma on the axilla

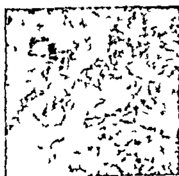


Fig 5—Nocardia minutissima in scale
(McGuire's stain)

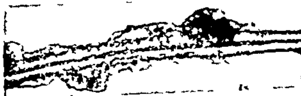


Fig 6—Trichomycosis nodosa (axillary hair)

*See appendix

Culture—The organism can be easily cultivated on blood agar and the growth occurs after 24 to 48 hours as opaque white pinhead like colonies They appear as fine filaments with metachromatic granules The diameter of the organism is less than 1μ Branching of the filament is rare and smaller bacillary or coccoid forms are occasionally seen

Laboratory diagnosis is easily made by direct examination of the scales under the microscope by McGuire s stain For this the part is scraped with a Paget s knife and the scales are collected between a pair of sterile slides The scales are then treated with a drop of ether alcohol mixture and a coverslip preparation is made with the stain The wet preparation is examined under the 1/12 oil immersion objective *N minutissima* is seen on the scales as fine filaments with metachromatic granules (Pl III Fig 7 and Fig 5) Culture confirms the finding

Treatment—The part is kept dry by dusting Pulv sulphur et camphor* Lotio triple dye* may be painted once at night and this will stop the acute oozing condition within a few days A 10 per cent solution of sodium propionate in alcohol may be sponged twice daily

TRICHOMYCOSIS NODOSA

Nodosities of the hair is caused by *Nocardia tenuis* and characterised by irregular deposit of small excrescences along the hair shaft which can be better felt than seen They are black red or yellow in colour The disease is seen in the axillary or pubic hair The affected hair does not become brittle The disease is a chronic one and does not cause any inconvenience except that it often colours the sweat which invariably stains the under garments

The cortex of the hair shows development of concretion in the middle or subterminal parts of the hair (Fig 6) In the parasitic life the fungus often appears in the shape of bacillary or coccobacillary form packed clo ely and embedded in an amorphous cementing substance

Laboratory diagnosis Preparations from the hair often shows coccobacillary forms The organism can be cultivated in suitable media avoiding secondary contaminants like Micrococci (Rhodococcus Nigrococcus) always associated wi h it When the material is treated sufficiently with ether alcohol mixture conta mination can b avoided They may be cultivated in ascitic fluid agar Dorset s egg media or Petroff s media They produce semi transluscent granular mammillat ed colonies which are cream coloured (Pl III Figs 8 and 9) A pure culture should not show red or black colour due to the growth of Micrococci

The organism is 0 2 to 0 6 μ in breadth and 2 to 10 μ in length with occasional branching (Pl III Fig 10) They are Gram positive non acidfast coccobacillary forms are also seen

Treatment The hair should be clipped short and should not be allowed to grow long Dusting of the affected region with Pulv sulphur et camphor* will keep the part dry and will stop the growth of the fungus

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* appendix

SUBORDER BLASTOSPORINEAE Vuillemin 1911

Order Thallosporales Vuillemin 1910

Blastosporineae are hyphomycetes more than 1 μ in diameter and reproduce by blastospores i e by budding of cells The buds are spherical or ovoi in shape and continue to multiply without any resting phase

Family Cryptococcaceae Kutnitz 1833 The cells are isolated reproduce by budding or pseudomycelia They may or may not ferment sugars

Subfamily Cryptococcoideae Reproduce by budding and a few pseudo mycelia Mycelia may form in culture Sugar is not fermented

Genus Cryptococcus—Reproduce exclusively by budding in tissue and culture e g *C neoformans*

Genus Pityrosporum—Reproduce by budding and pseudomycelia found in various distorted forms in tissue difficult to grow in culture e g *P ovale*

Genus Blastomyces—Budding forms are seen in the tissue and in culture at 37 C and mycelia with conidia develop at room temperature e g *B dermatitidis B brasiliensis*

Genus Coccidioides—Spherules and sporangia like structures in tissue mycelia and chlamydospores are seen in culture e g *C immitis*

Genus Histoplasma—Budding forms are seen in the tissue and in culture at 37 C mycelial form small conidia and prickled chlamy dospores are seen in cultu e at room temperature e g *H capsulatum*

Genus Phialophora—Budding singly or in pairs in tissue and mycelial form and spores in culture e g *P verrucosa*

Subfamily Candidoideae—Yeasts wit i true mycelia and blastospores *

Genus Candida—Mycelial and budding forms are seen e g *C albicans*

Genus Malassezia—Mycelia and blastospores with double wall e g *M furfur*

BLASTOMYCETES (Yeast like fungi)

Yeasts are unicellular organisms of the vegetable kingdom often oval in shape They reproduce predominantly but not exclusively by budding In simple budding the cell wall shows protrusion through which protoplasm bulges out The bud remains attached to the mother cell so long as it is not mature After maturation the bud assum s the character of a mature cell and eventually becomes detached

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* In the classification by Dodge Genera Trichosporum and Geotrichum are included in Candidoideae but in this book it has been put under Blastoarthrosporineae instead of Blastosporineae

Cytology Yeast cells consist of protoplasm with a cell wall. The cell contains a single nucleus and numerous *granules and vacuoles representing* reserved food matters. The cell wall is thin when young but as the cell becomes *old the cell wall* becomes thicker and the cell becomes filled up with granules and vacuoles. Many of these granules are *volutin or metachromatic* granules.

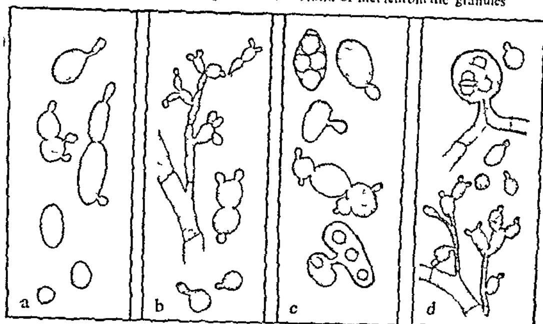


Fig 7—(a) *Cryptococcus* (b) *Candida* (c) *Saccharomyces* (d) *Endomycopsis*

Reproduction of yeasts According to the mode of reproduction yeasts are divided into sporogenous and asporogenous yeasts. The sporogenous yeasts undergo sexual reproduction and belong to the class Ascomycetes comprising two important genera namely Saccharomyces and Endomycopsis under the order Endomycetales. The former reproduces vegetatively by budding only but the latter *reproduces both by budding and mycelia*. *Asporogenous yeasts do not* show any sexual reproduction and so belong to Fungi Imperfecti. They reproduce only by budding as in the genus Cryptococcus but in the genus Candida they reproduce both by budding and mycelial forms. The reproductions of sporogenous and asporogenous yeasts are shown in Fig 7.

CRYPTOCOCCOSIS

Synonyms Torulosis. *European blastomycosis*. Torula meningitis.

Definition It is a rare disease caused by *Cryptococcus neoformans* with a predilection to produce lesions simulating tuberculous meningitis, brain abscess or brain tumour. It may cause *granulomatous lesions of the skin*, lung and other tissues of the body. Respiratory tract is the probable portal of entry.

History *Busse (1894 95) in Germany* isolated a yeast from the localised subperiosteal infection of tibia which subsequently became generalised and the patient died of multiple lesions of the skin and viscera. Hansemann (1905)

isolated a yeast like organism by lumbar puncture of a suspected case of tuberculous meningitis Stoddart and Cutler (1916) in U S A reported two cases presenting signs and symptoms of cerebral tumours caused by yeasts and the organism was called *Torula histolytica* Vuillemin (1898) placed the fungus in the genus Cryptococcus and now the accepted name for this organism is *Cryptococcus neoformans* *C neoformans* and *T histolytica* causing cryptococcosis in America and Europe respectively were shown to be identical by Benham (1935)

Etiology Males are more frequently affected than the females Most of the cases are between the ages of forty and sixty The causative organism is *C neoformans* a budding fungus which does not show formation of mycelium or sexual spores and belongs to the class Fungi Imperfecti

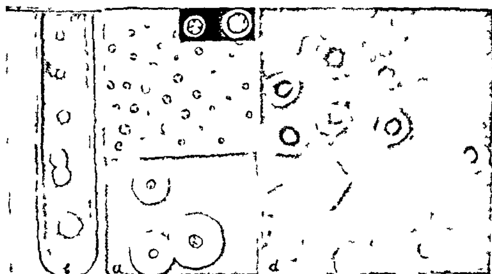


Fig 8—(a) Cerebrospinal fluid showing capsules of *C neoformans* in Indian ink preparation (b) Culture on glucose agar (c) Yeast form in culture (Saline preparation) Inset—same in Indian ink preparation (d) Budding forms as seen in section of the brain

Mycology *C neoformans* may be found in the sputum pus cerebrospinal fluid in subjects suffering from cryptococcosis The fungus in the tissue is a single budding cell ovoid or spherical measuring 5 to 10 μ in diameter They are surrounded by a clear halo representing a wide gelatinous refractile capsule The capsule is better demonstrated in the exudate or culture under a coverslip preparation with Indian ink (Fig 8a) In the tissue it may be stained with methylene blue Gram Weigert haematoxylin and eosin or van Gieson's stains Yeast cells may show marked variations in size The cytoplasm which is refractile stains poorly In the tissue there is a clear zone of gelatinous material round the organism (Fig 8d) and this finding led to name the parasite *Torula histolytica* The parasite is Gram positive when young but Gram amphophil when old

Culture—The organism is an aerobe and grows very well in all laboratory media preferably in blood agar The organism can be isolated from cerebro spinal fluid pus or other exudates and occasionally from blood To isolate from contaminated material 0 3 per cent lactic acid is added to the medium and growth of the secondary organisms is thus inhibited All material should be cultured on blood agar and glucose agar at 37 C and on Sabouraud's glucose agar at room temperature The growth has a tendency to dimorphism *On glucose agar incubated at 37 C Small* mucoid colonies develop cream to brown in colour (Fig 8b) Microscopically they show capsule formation On Sabouraud's glucose agar *at room temperature the organism grows slowly* producing white wrinkled granular colonies Microscopically yeast forms are seen (Fig 8 c) and rarely germ tubes in the form of pseudomycelia On continued subculture shining mucoid cream to brown coloured colonies develop Capsules are best demonstrated in Indian ink preparations

Biochemical reactions are too variable and are not useful for diagnosis

Animal inoculation Mice and rats are susceptible but guinea pigs and rabbits are less susceptible By animal inoculation the pathogenicity of the fungus can be determined and thus a pathogenic strain can be distinguished from a nonpathogenic one by animal inoculation

Symptoms Occasionally localised lesions may appear in the skin mucous membrane lymph nodes but the organism commonly affects lungs and central nervous system In the skin the primary lesions are acneform papules granulomatous lesions punched out ulcers or deep seated myxomatous tumour or abscesse Many cutaneous cases may show generalised infection with involvement of lung and central nervous system Lymphatic involvement may simulate Hodgkin's disease The pulmonary involvement produces symptoms mistaken for *tuberculosis or neoplasm Central nervous system is* seen to be affected in majority of cases and symptoms may resemble those of encephalitis or acute meningitis of bacterial origin like tuberculous meningitis nevertheless they may *appear as abscess or tumour of the brain* The pressure of the cerebrospinal fluid is increased characterised by papilloedema and there is increase of albumen and globulin in the cerebrospinal fluid The cell count of the cerebrospinal fluid is high and chloride and sugar contents are low Death occurs in coma and respiratory failure

Pathology In the central nervous system the organism often produces condition of *leptomeningitis In the brain a chronic inflammatory process* [illegible] produce cysts which contain a gelatinous substance due to abundance of capsular material produced by the organism Tubercle like structures may be seen along the blood vessel with thick exudate at the base of the brain resembling th[illegible] tuberculous meningitis

Histopathology In sections from the biopsy material stained with haematoxylin and eosin the budding cells are seen surrounded by capsular substance (Fig 8 d) The fungus may be free in masses with lack of inflammatory cell[illegible]

pseudotubercles may form containing epitheloid cells giant cells and lymphocytes The centre may be either necrosed or hyalinised in some cases

Sputum pus gelatinous material from the cyst and the centrifuged deposit of cerebrospinal fluid contain the organism which can be demonstrated by a saline or Indian ink preparation

Immunity All attempts to demonstate antibody response in patients suffering from cryptococcosis have given negative results It was shown by Benham (1935) that the encapsulated fungus did not produce any circulating antibody when injected into animals but high titre of circulating antibodies were obtained when the thick capsule was removed or the gelatinous material was injected into animals

The extract of the organism shows specific cutaneous reaction but this requires further confirmation

Laboratory diagnosis Lesions of the skin or lymph glands are diagnosed by biopsy and culture from the infective material Pulmonary lesions must be differentiated from other mycotic infections and tuberculosis Presence of *C neoformans* is characteristic and can be demonstrated by positive cultures In meningitis the cerebrospinal fluid should be examined as a routine examination for the presence of *C neoformans* by direct examination and culture

Prognosis Localised lesions in the skin and subcutaneous tissues may subside and heal in a few months but the systemic torulosis is always fatal

Treatment Localised cutaneous lesions may be removed surgically and cauterized followed by X ray therapy Sulphonamides may be tried in adequate doses to maintain the blood concentration between 10 and 12 mg per cent The organism is sensitive to penicillin but as it does not reach the central nervous system it may be administered intrathecally in cases of involvement of the central nervous system

PITYROSPORUM OVALE Kile and Engman 1938

Synonyms Flask bacillus of Unna *Malassezia ovalis* (Bizzozero 1884) Panja 1927 Pityrosporon of Malassez

This is an yeast like organism first described by Malassez in 1874 The organism is also called bottle bacillus of Unna found in the dandruff or scraping from the scalp These are ovoid or spherical cells with budding on a broad base and often appear to be flask or bottle shaped (Fig 9) The cells vary from 2 to 10μ in diameter

Culture Culture of *P ovale* is one of the problems for dermatologists as it is difficult to cultivate them Cultures do not give uniform results and failure is often a rule than an exception Failures are often due to contaminations Successful cultures have been obtained by Panja (1927) in cent per cent of cases by MacLeod and Dowling (1928) Ota and Huang (1933) Benham (1939) and Emmons (1940) and others Moore claimed to have cultivated *P ovale* in wort agar (Difco) and after three or four days subcultures were obtained in other media from the primary growth He reported success in about 10 per cent of cases only

Method of Panja This gives uniformly good results in all the cases provided suitable media and proper precautions are employed *Scales are obtained* from the scalp by scraping with the help of a scalpel and the material is collected between a pair of sterile slides The scales are picked up with a needle put in a watch glass containing sterile normal saline and washed for some time Small bits of scales are then picked up with the help of a platinum loop and transferred to the upper drier part of Petroff's medium with 0 004 per cent gentian violet * Four or five inocula may be made in each tube and 3 or 4 tubes should be inoculated at a time The tubes are incubated at 37 C The growth is visible in two or three days time Two types of growths are seen in the primary culture —

(1) Chalky growth specially seen on the dry part of the above medium near the tail end of the slope The chalky surface gradually extends at the periphery by fine concentric rings The centre of the growth often forms a pyramidal mass with a ring at the top resembling a truncated cone

(2) On the moist part of the medium bead like masses develop often mammillated with a pinkish colour which may develop further into orange colour after a few days



Fig 9—Bottle bacilli in scale ×970

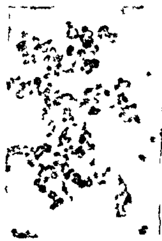


Fig 10—Bottle bacilli in culture ×[illegible]0

Subcultures on glucose agar or Sabouraud's glucose agar The growth is appreciable in 2 or 3 days time as a crenated mass with irregular spike like projections on the surface or a star like growth with distinct radial striations They become mammillated with radial striations in different directions The striations are best observed in transmitted light Growths on glucose or glycerine agar are scanty but if sterile olive oil is spread on the surface of the medium the colonies assume large thick creamy characters in 24 hours *Ghee* butter oleic acid or lanoline may also be used instead of olive oil The oil is autoclaved

* See Appendix

in a test tube A few drops of the sterile oil are put into the media tubes and spread on the surface of the slope by tilting the tube The excess of the oil is allowed to settle at the bottom The medium is then inoculated with the culture of *P ovale* The colonies appear as opaque creamy large colonies like those of yeasts The growth is more profuse near the bottom of the slope To maintain profuse growth the oil is to be spread on the surface of the medium by tilting the tube once a day Microscopically they show budding forms the majority being 5 to 10 μ in diameter (Fig 10)

Moore's method Wort agar medium (Bacto) is used for the culture of *P ovale* Growth appears on the fourth day after inoculation The growth is slow and colonies are compact smooth and glistening For subculture maltose dextrose or peptone agar is used * Wheat germ oil or butter is added to this medium as it has been found that the organism requires a fatty environment According to Moore colonies of *P ovale* become 2 cm in diameter after forty days They are cushion shaped with radiating ridges at the periphery and the surface is rough with small excrescences The colour is dull and varies from light ochraceous salmon to pinkish buff

Microscopically cells are 3 to 15 μ in diameter the majority being 4 to 5 μ Budding cells are present resembling the shape of a flask or gourd The larger old cells are encapsulated with thick gelatenous coating

Growth factors of *P ovale* have been worked out by Rhoda W Benham She has shown that the fungus is lipophilic and thiamine and oxalacetic acid act as growth factors Thiamine causes increase of the growth when added to a basal medium with asparagin or ammonium chlorid as a nitrogen source The growth is much better with asparagin than with ammonium chloride Ethyl oxalacetate can replace thiamine Again ethyl oxalacetate and ammonium chloride can be substituted for asparagin and thiamine in the cultivation of *P ovale*

Animal inoculation Inoculation of animals and human subjects with *P ovale* has been reported to be successful by Moore et al (1926) as it produced clinical and pathological picture (dermatitis showing erythema or brown scaliness) resembling seborrhoeic dermatitis But it has been frequently noticed that dermatitis of similar type may be produced by application of yeasts and yeast like organisms on the abraded skin

SEBORRHOEIC DERMATITIS

Synonyms Pityriasis capitis Seborrhoea (Hebra) Hyperidrosis oleosa (Unna) Flux sebacea (Rayer) etc

Definition The condition is supposed to be caused by infection of the scalp by *P ovale* which grows on the surface layers of the epidermis and produces a furfuraceous desquamation The infection of the epidermis is predisposed by excessive oiliness of the skin as a result of overactivity of the sebaceous glands

* See appendix

Etiology During the first three years of life the soil is suitable for implantation of *P ovale* According to Acton the cause of seborrhoea is as follows —

Primitively the embryonic skin consists of two layers *(a) basal layer* of columnar cells and (b) Rauber s layer consisting of swollen cells which do not *keratinise till birth* This is due to formation of some fatty substances or *vernix caseosa* which acts as a water proof coating preventing maceration of the skin by liquor amnii It is this superficial layer of the skin where *P ovale* first infects during the first three years of life After birth presence of remnants of vernix caseosa can also favour the growth of this organism The infection primarily affects the scalp and then spreads on to the face and extremities In the adult life the infection occurs in relation to sebaceous glands To understand the sites of infection distribution of sebaceous glands of the skin is to be understood Sebaceous glands are of two main types (a) Sebaceous glands which are not connected with hair as an appendage They are large or racemose in character and (i) connected with sexual organs as in the scrotum labia prepuce and axilla They produce volatile fatty oils imparting a distinct odour to the individual or species (ii) Sebaceous glands connected with lubrication of various orifices of the body e g ceruminous glands of the ear Meibomian glands of the eyelids In these areas *P ovale* may cause boils of the external auditory meatus styes blepharitis retention cysts etc (b) Pilosebaceous glands occur as appendages at the root of the hair follicles and found in places where hair is present These are further differentiated into three varieties (i) Sebaceous glands that are at the root of long hairs These are single saccular or bilobed i e long hairs have small glands (ii) Sebaceous glands at the root of lanugo hairs are large and racemose in character (iii) Multi lobed large racemose glands are present in areas where glands have lost the relationship to the hairs They are mostly seen in the forehead naso labial folds back of the neck mid thoracic and inter scapular regions There is a minimum amount of subcutaneous fat in these regions These are the sites where seborrhoeic dermatitis is seen

Physiological overactivity of the sebaceous gland occurs during the first three months of life and at puberty Oily condition of the skin favours the growth of *P ovale* According to Sabouraud greasy skin is not essential for seborrhoea but the moist condition which predisposes seborrhoea is essential and is due to serum and not sebum At puberty along with sex glands sebaceous glands become more active

Heredity plays an important part in determining the number and size of sebaceous glands Certain individuals are predisposed to this condition by virtue of inheritance of the skin containing numerous sebaceous glands

Sex Baldness is comparatively rare in women and this might be due to the influence of different gonadal hormones in males and females

Endocrine dysfunction The condition of seborrhoea is common at the advent of puberty when there is an imbalance of endocrine glands specially the gonads At that time the sebaceous glands become hypertrophic and more active

producing a condition of seborrhoeic state The male gonad or androgen is particularly responsible for this condition and helps in the formation of a suitable soil for the growth of *P ovale*

Mode of life A sedentary city life with lack of exercise predisposes to seborrhoea and exposure to the sun often increases the condition

Food Diet rich in carbohydrate or fat producing lack of digestion predisposes to seborrhoea It has been observed that deficiency of vitamin B-complex which makes the patient sensitive to sunlight sets up keratosis and exfoliation of the naso labial folds

Relative acidosis Urine is highly acid in seborrhoeic patients and the alkali tolerance of the patient is high as large doses of alkalies are necessary to make the urine alkaline

Age Seborrhoea commences in early life shortly after birth due to extraneous infection of *P ovale* which is the determining factor A few days after birth vernix caseosa is shed off and the superficial layer of the skin begins to keratinise Scalp with the presence of vernix caseosa forms a good soil for the growth of *P ovale* Once the infection occurs the disease progresses upto the age of three years after which the seborrhoeic manifestations disappear temporarily At puberty it reappears and continues for the rest of life At puberty the activity of the gonads increases giving rise to a peculiar condition of the skin that predisposes to pityriasis capitis and acne Darier has described the condition as kerosis in which the complexion of the patient is muddy and the skin is coarse greasy and thickened mouths of the sebaceous glands are large and patent

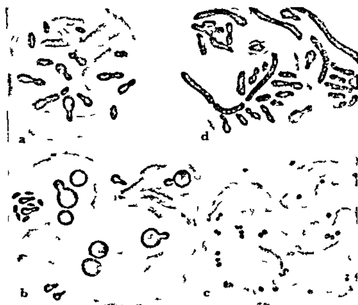


Fig 11—Bottle bacillus ovale a and b—flask form c—coccal form d—mycelial form

but many of them are blocked with dried up inspissated sebum forming black heads (comedones) The condition often disappears spontaneously at the age of 25 years or so but it may persist through out the whole life

Organisms The rôle of the organisms responsible for seborrhoeic condition is still disputed but it is a fact that *P ovale Staphylococcus albus* and *Coryne bacterium acne* form the seborrhoeic triad *P ovale* is found in flask shaped form (bottle bacillus of Unna) coccal form *(morococcus of Sabouraud) or* rarely in the rudimentary mycelial form (Fig 11) Coccal forms are seen *when the disease is spreading rapidly* *C acne* is *specially found* in acne vulgaris Experiments of MacLeod and Dowling have proved that seborrhoeic infection is a pure fungus infection with *P ovale* The organism grows well in subjects with moist and greasy skin

Signs and Symptoms Seborrhoeic lesions are best described under three *age groups* *The types of the lesion and their symptoms vary according to the* age and the area affected

(a) INFANCY *Milk crust* This condition develops within a few days after birth if vernix caseosa is not thoroughly removed The child becomes infected with *P ovale* from the mother or the nurse In this case vernix case osa acts as an ideal culture medium for its growth The scalp becomes inflamed and very irritable resulting in serous exudation and crust formation The *scalp is covered with a cap of hair matted with exudate mixed up with dirts* and contains the infecting fungus Impetigo is superimposed on it in many cases *due to infection of the skin caused by streptococci*

Infantile eczema There are various causes of infantile eczema but in certain cases it is due to extension of the lesion from the scalp to the skin of the forehead cheek behind the ears flexures of the body outer side of the legs It is characterised by serous exudate due to secondary streptococcal infection producing yellow crusts like impetigo There is an intense itching associated with it Food allergy may maintain the condition or aggravate it *These children are often subjects of prickly heat impetigo and boils in the later life*

Liver spots These are localised patches of seborrhoeic dermatitis with superficial *exfoliation and development of hypopigmented* patches on the face and back popularly known as liver spots

(b) FROM PUBERTY UP TO THE AGE OF 25 YEARS *Seborrhoea capitis* (Pityriasis sicca of Hebra dandruff) It is a dry scaly condition of the scalp which is very common during adolescence Bran like scales accumulate on the scalp causing exfoliation of the outer horny layer and mild irritation of the skin

Seborrhoea oleosa (Hebra) This usually occurs at puberty characterised by the greasy condition of the skin containing *P ovale* They are the subject *of acne vulgaris and seborrhoeic alopecia in later life*

Seborrhoea corporis The condition is also called flannel rash owing to the old conception that it was *due to wearing flannel garments* next to the skin The infection spreads from the scalp to the front of the chest and the trunk There

are irregular hypopigmented circinate patches of different sizes varying from a four anna bit to that of a rupee Lesions are seen on the face neck sternal and interscapular regions but they may spread to other parts of the body as arms thighs genito-crural region and perineum

Seborrhoeic eczema This is a dry scaly condition of the neck face and eye lids but later they may show a weeping eczematous condition on the flexural aspects of the axillae elbow or knee joints

Seborrhoeic lichen This occurs as a result of irritation or itching and is generally seen on the nape of the neck and flexures of the elbow and other regions where there is a condition of seborrhoeic eczema This starts as a crop of papular rash in patches due to hyperkeratosis of the hair follicles It is associated with thickening of the skin on the nape of the neck with raised margin scaliness and pigmentation in seborrhoeic subjects

(c) FROM 30 TO 45 YEARS *Seborrhoeic baldness* During this period the infection is restricted to the scalp and involves the true pilosebaceous glands The infection destroys the glands as well as the hair follicles producing seborrhoeic alopecia or baldness The baldness may start from the crown and extend towards the forehead or it may start from the forehead and spread towards the crown of the head Baldness is diffuse and complete within a few years The whole of the forehead and vertex of the scalp is denuded of the hair the skin becomes shiny and only a little area on the side and back of the head shows thin growth of hair

PREDISPOSITIONS Prickly heat is one of the seborrhoeic predispositions and the condition is characterised by the infection of sweat pore by staphylococci The epidermis at the top of the vesicle shows both staphylococci and *P ovale* It is usually seen in persons suffering from seborrhoea of the scalp

At the age of puberty the condition of kerosis is commonly seen The pilosebaceous glands which undergo hypertrophy are exposed to infection by staphylococci and *P ovale* *C acne* also invades the sebaceous glands when mouths of the glands are obstructed and partial anaerobiasis is produced this is favourable for the growth of *C acne* The glands that are usually attacked are those of naso labial folds forehead sternal and interscapular regions In deep seated lesions they produce scars which may subsequently form keloids The mouths of the glands are blocked and form black heads (comedones) due to drying up of sebum mixed with dirts but in other cases retention cysts are formed

Pathology *P ovale* grows on the superficial layers of the epidermis and appears as yeast like budding forms During multiplication it causes alteration in the superficial cells preventing them from perfect keratinisation In the affected areas the scales are cast off as tiny delicate pellucid scales called dandruff When the disease is rapidly spreading rounded coccal or rarely mycelial forms are seen In seborrhoeic alopecia the horny layer in the hair follicle fails to keratinise and the mouth of the follicle is filled with large swollen cells Deeper in the follicle minute coccal forms and yeast forms are seen as far down as

pilosebaceous glands which are surrounded by an inflammatory zone of leucocytes The hair is distorted in shape and later on the hair root undergoes atrophy and subsequently the hair follicle is obliterated resulting in baldness of the scalp

Treatment In treating cases of seborrhoea it should be remembered that the primary site of infection is the scalp and sulphur in various forms is the drug of choice Secondary infections are responsible for the persistence of eczematous lesions in infants

Milk crust In this condition prophylactic measure is very important and thorough removal of vernix caseosa should be strictly adhered to This can be done by rubbing olive oil on the scalp followed by gentle rubbing with soap and water to remove every trace of oily matter Should any scaliness persist lotio resorcin diluted with equal parts of water should be applied on the scalp Application of 0 5 per cent hydrarg oleata in olive oil is also useful In established cases of infection sulphur salicylic ointment (15 grs of each in an ointment base) should be applied

Infantile eczema Treatment in these cases should be local and general Weeping eczematous lesions on the face (eczema rubra) are best treated with lotio calamine in the weeping stage till the part dries up When the part is dry and weeping has stopped liniment calamine with sulphur (10 grs to an ounce) should be applied thrice daily followed by application of 3 per cent resorcin ointment at night In this primary infection of the scalp should be remembered and lotio resorcin (diluted) should be used as mentioned before The general treatment consists of relieving constipation by administration of gray powder in doses of 1/4 to 1/6 gr according to age twice daily Treat the coexisting food allergy by changing the milk or the diet as the case may be

Seborrhoea capitis In this and other seborrhoeic conditions in adults remove the scales and promote the free flow of sebum by keeping the gland orifices clean with application of spirit soap or ether soap shampoo (See appendix) The shampoo may be rubbed twice weekly If it is rubbed more frequently the affected hairs which become brittle may break As an antiseptic and exfoliative lotio resorcin et hydrarg perchloride is an effective application on the scalp For seborrhoea oleosa 1 per cent oleate of mercury in olive oil is effective for cleaning the scalp For seborrhoea of the face and body lotio sulphuris alba and Pulv sulphur et camphor should be applied alternately each twice daily The former is a time honoured remedy for seborrhoea of the body and the latter is used in the summer when one perspires profusely Lotio sulphuris flava is almost as efficacious as lotio sulphuris alba On flexural eczema and other irritable conditions liniment calamine with sulphur (10 to 15 grs per ounce) is indicated along with other remedies In seborrhoeic lichen the above treatment should be combined with application of unguentum acid salicylic on the affected part at night as an exfoliative The patient responds very well with this treatment

Acne vulgaris In this condition along with the local applications general treatment is al indicated Constipation dyspepsia indigestion should be treated

The quantity of carbohydrate and fat in the diet is reduced Intake of alcohol and highly spiced food are restricted Administration of vitamin B complex yeast marmite and liver extract are useful All attempts should be made to improve the general health of the patient and iron should be administered a tonic

BLASTOMYCOSIS

Synonyms North American blastomycosis Gilchrist s disease Chicago disease

Definition This is a chronic infectious disease caused by a yeast like fungus called *Blastomyces dermatitidis* characterised by primary granulomatous lesion of the skin or lung and secondary metastatic lesions in other parts of the body

A few doubtful cases have been reported from India



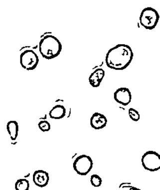


Fig 12—Budding cells in tissue of Blastomyces

History The organism was first discovered by Gilchrist (1896) in a section of skin lesion resembling tuberculosis In a second case Gilchrist and Stokes (1898) cultivated the causative organism and named it *Blastomyces dermatitidis* The organism was extensively studied by Ricketts (1901) who differentiated it from true yeasts and called it *Oidium dermatitidis* Vuillemin named it *Cryptococcus gilchristi* which terminology was supported by Sartory and Castellani It was placed in the genus Mycoderma by Brumpt

Mycology *Direct examination* A coverslip preparation is made with a loopful of pus or sputum with a 10 per cent solution of potassium hydroxide It shows characteristic round or oval thick walled double contoured refractile yeast like bodies with budding 8 to 20 μ in size The bud has a thinner wall than the mother cell These cells are highly granular bodies and occur singly in pairs or groups and are pathognomonic of this infection (Fig 12)

Culture Dimorphism is characteristic Primary cultures are made on blood agar and glucose agar and incubated at 37 C The fungus grows slowly and the culture should not be rejected as negative before one month The colonies develop as waxy wrinkled growths On microscopic examination

budding yeast like cells are seen resembling those in the lesion *Subcultures* on Sabouraud's glucose agar at room temperature exhibit downy growths characterised by aerial mycelia which are at first white but become brownish with age (Fig 13a) Microscopically it shows mycelia with oval or round conidia 3 to 4 μ in diameter attached to the hyphae Pyriform conidia are about 5μ in length and borne on lateral sterigma In old cultures chlamydospores are seen 7 to 8 μ in diameter with thickening of the wall (Fig 13b) Mycelial form may be converted into yeast form by incubating the subcultures at 37 C



Fig 13—(a) Culture of *B dermatitidis* on Sabouraud's agar at room temperature
(b) Culture showing mycelia bearing conidia

Animal inoculation The mouse is the most susceptible animal rats and rabbits are less so and guineapigs are the least susceptible Any phase either the mycelial or the budding one injected into mice causes local lesion followed by visceral lesions of the liver spleen or lungs in about 3 weeks

Pathology The stages of evolution are those of an infective granuloma Minute abscesses are formed as a result of necrosis Lesions in the skin may be in the form of a nodule papillomatous or a gummatous ulcer but lesions in the lungs or viscera show abscess formation with ulceration The lesions spread by continuity and contiguity Dissemination may occur through the haemato genous route

Histopathology The histopathological changes are those of a granuloma In the skin lesions acanthosis and papillomatosis are marked There are minute intraepidermal and intradermal abscesses in which budding yeast cells are present Interstitial and parenchymatous oedema is present in the underlying cutis where changes are essentially those of a granuloma The abscess consists of degenerated polymorphonuclear neutrophils which are found around the organism Beyond the zone of polymorphs there are macrophage with formation of giant cells of Langhans type containing the organism Fibroblasts are present at the periphery The characterestic round or oval budding cells are present in the pus and best stained by polychrome methylene blue

Symptoms The period of incubation is not definitely known but it varies from one to two weeks Clinically blastomycosis is divided into

(a) **Primary cutaneous blastomycosis** In this the primary lesion is in the skin and secondary systemic involvement is seen in about 33 per cent of these cases specially in the lung

(b) **Systemic blastomycosis** 95 per cent of these cases show extensive pulmonary involvement The condition is extremely fatal Dissemination occurs in the bone (60 per cent) liver spleen and kidney (40 per cent) central nervous system (30 per cent) and in the prostate (20 per cent)

Cutaneous blastomycosis It may manifest itself as primary papulo ulcerative lesion papillomatous or granulomatous ulcers or as subcutaneous nodules forming ulcers covered with scabs Exposed parts of the body namely face lower part of the legs and hands are more often infected In these cases trauma may play an important part The centre of the lesion often heals up and the spreading margin of the lesion shows miliary abscesses with crust formation When the crust is removed the granulation tissue or small sinuses are seen with seropurulent discharge containing the fungus Cutaneous lesions secondary to systemic affection shows superficial or deep ulcers with granulation tissue and exudation of pus forming crusts Multiple lesions may appear in the skin as a result of autoinoculation Metastatic spread may occur from the skin to internal organs

Pulmonary blastomycosis It is usually a primary involvement but may be secondary to a focus in the skin Systemic blastomycosis has also a tendency and affinity for metastasis in the lung The primary infection occurs through the respiratory tract The onset may be insidious but it may be rapid in acute cases In these cases pain in the chest fever cough dyspnoea and expectoration of blood tinged sputum and loss of weight are characteristic The chest signs are like those of a pulmonary abscess or massive tuberculous infection Pulmonary blastomycosis should be suspected if discharging sinuses or subcutaneous abscesses are seen over the chest wall

Cerebrospinal blastomycosis This is usually a secondary condition and occurs as a metastatic process from a primary focus Signs and symptoms are similar to those of cerebrospinal infection due to other mycotic organisms

Diagnosis The diagnosis depends on the demonstration of *B dermatitidis* in the pus sputum or cerebrospinal fluid by direct microscopic examination The material is examined with a drop of 10 per cent potassium hydroxide and budding cells with refractile capsules should be observed Culture should also show the growth of the organism Histopathological examination of the skin lesion will show a granulomatous lesion showing budding cells with double contour

Intradermal test with a standardised heat killed vaccine is useful in the diagnosis of the disease The reaction is of tuberculin type 0 1 c c of the vaccine is injected intracutaneously and readings are taken after 12 24 and 48 hours Positive reaction shows an area of erythema of 1 cm or more in diameter after

48 hours In highly sensitised patients a sterile abscess forms after 48 hours. Complement fixation test with suspension of the organism as antigen is also positive in these cases. Both skin test and complement fixation test should be done because when the complement fixation test is negative the skin reaction may be positive and vice versa but there are cases in which both the tests are positive. Positive skin test indicates presence of hypersensitiveness.

Prognosis Primary cutaneous lesions may be cured if proper teatment is given early in the diseases but 92 per cent of *systemic involvement become fatal*. Prognosis in cerebrospinal cases is always grave. Prognosis is best in hypersensitive *cases but without positive complement fixation test* which indicates spread of the lesion.

Treatment Whatever therapeutic measures are taken proper care should be taken about the general health of the patient. Sun shine vitamins high caloric diet are essential for the well being of the patient.

In the cutaneous type complete resection followed by *cauterisation* with diathermy is advisable in early cases. A full dose of Pot. iodide orally upto the *limit of tolerance should be supplemented by 1 to 2 gm.* of Sod iodide by intravenous route. Iodide in big doses may be harmful in hypersensitive cases. Martin and Smith therefore advise desensitisation of the patient with vaccine before the iodide therapy. X ray therapy is useful in doses of 125r through 1 mm. aluminum filter for several exposures. This therapy should be administered after the patient has been desensitised with specific vaccine therapy.

Specific therapy In systemic blastomycosis iodide treatment is combined *preferably* with autogenous *vaccine*. *Otherwise* a standardised vaccine may be used for this purpose. The initial dose is 0.1 c.c. and it is increased by 0.1 c.c. on every alternate day *till 1 c.c. is reached. The increase of dose should depend* on the absence of skin reaction. If the skin reaction is 1 cm. or more the vaccine is diluted to 1 in 100 *if the skin reaction is 2 cm. or so the vaccine* should be diluted 1 in 1000 and so on.

SOUTH AMERICAN BLASTOMYCOSIS

Synonyms Paracoccidioidal granuloma. Lutz Splendore de Almeida's disease.

Definition South American blastomycosis is a chronic granulomatous ulcer of the skin and *mucous membrane* with enlargement of the lymph nodes and involvement of the internal organs caused by *B. brasiliensis*. The granulomatous and ulcerative lesions *of the oral mucosa enlargement of the lymph* nodes and involvement of the gastro intestinal tract differentiates the condition from North American blastomycosis. The lungs *are rarely affected in this* condition.

History Lutz (1908) reported the first case of pseudo coccidioidal *granuloma* of the mouth and regional lymphatics occuring in Brazil. But the first case of generalised paracoccidioidis was reported by Splendore (1919). Arantes *(1920) and* Fonseca (192 1929) described the organism as *Coccidioides immitis* but de Almeida (1930) compared the cultures of *C. immitis* with those of South American blastomyces *and found them to be different*.

Etiology The disease is endemic in South America particularly in Brazil but cases have been reported from Argentina Paraguay Peru and Venezuela It is found in people of rural communities Males are more commonly affected than females (10 1) The causative fungus *Blastomyces (Paracoccidioides) brasiliensis* has been isolated from the lesion soil and natural substrates The infection often follows a trauma

Mycology *B brasiliensis* like *B dermatitidis* is dimorphic and both yeast and mycelial forms are seen In the tissue pus or culture at 37 C single or multiple budding cells are seen the latter is diagnostic Buds unlike those of *B dermatitidis* are coccoid small measuring 1 μ or more They are typically multiple and arranged round the mother cell Single budding cells are 10 to 30 μ in diameter but the multiple budding cells may be as large as 60 μ (Fig 14)

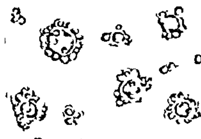


Fig 14—Characteristic budding of *B brasiliensis* in pus



Fig 15—*B brasiliensis* on Sabouraud's glucose agar at room temperature 4 weeks old

Culture The infective material is cultured in blood agar and Sabouraud's glucose agar and incubated at 37 C and at room temperature On blood agar incubated at 37 C the culture is yeast like and single and multiple budding forms are seen like those in the lesion On Sabouraud's agar incubated at room temperature the growth is heaped up glabrous and cerebriforme like that of *Trichophyton schoenleinii* These often show budding cells but soon the growth is covered with white aerial mycelia (Fig 15) They show filamentous mycelial forms with small smooth walled round or pyriform conidia and chlamydospores

Animal inoculation Mice are inoculated intraperitoneally but guineapigs are inoculated intraperitoneally and intratesticularly The fungus can be studied from the pus and cultures may be obtained from the lesions after their development

Clinical types Several clinical types have been described (1) Mucocutaneous type which starts from the buccal mucosa as a granulomatous ulcer and affects the oral mucous membrane and nose (2) Lymphangitic type in which groups of lymph nodes are enlarged namely cervical supraclavicular and axillary lymph glands The adenopathy is like that of Hodgkin's disease (3) Visceral type with lesions in the intestine liver spleen pancreas and other internal viscera (4) Mixed type involving both the skin and internal viscera

Immunity The complement fixation test is positive in spreading cases indicating a bad prognosis It may be negative in early or treated cases The skin test is however, positive with paracoccidioidin *in cases with hypersensitivity*

Diagnosis Infective meterial may be obtained from (a) pus or scraping from the ulcer on the buccal *mucosa (b) Pus from a fluctuant* node (c) Smear or material from biopsical nodes (d) Sputum The material is examined in fresh *state under a coverslip with 10* per cent potassium hydroxide The fungus appears as single or multiple budding cells the latter is diagnostic of paracoccidioidal granuloma The organism should be cultured on artificial media Guineapigs are inoculated intratesticularly with the infected material and pure cultures may be obtained from the material after development of the lesion

Treatment Iodide has been advocated but it should *not be administered* without desensitisation of a hypersensitive patient Therefore before administering iodide, *skin test should be done for hypersensitivity* Recently it has been reported that South American blastomycosis responds very well to sulphapyridin *in all the stages of the disease when administered* over a long period Penicillin is not effective against *B brasiliensis* in vitro or in vivo

COCCIDIOIDOMYCOSIS

Synonyms Coccidioidal granuloma Posada s disease valley fever desert *reheumatism etc*

Definition It is a highly infectious disease casued by *Coccidioides immitis* and characterised by an acute primary benign (*self limited*) respiratory infection (Coccidioidomycosis) or a chronic progressive secondary disseminated granulomatous affection involving the lung skin subcutaneous visceral or osseous tissues and ending fatally The acute benign respiratory disease is known as valley fever or desert rheumatism Primary cutaneous lesions may however be seen with papillomatous or fungating lesions

History The first case of coccidioidomycosis was reported by *Posada (1892) and* Wernicke (1892) in Argentina affecting a Brazilian soldier The second and third cases were seen in California by Rixford and Gilchrist (1894) They *believed the parasite to be a protozoan* and named it *Coccidioides immitis* in 1896 Ophuls and Moffitt (1900) cultivated this organism and found it to be a fungus with filamentous mycelia Benign type was first described by Gifford (1936)

Geographical distribution The disease is endemic in San Joaquin valley of California and some parts of *Mexico A few authenticated cases have been* reported from South America No confirmed case has been reported from India

Sources of Infection *The organism pathogenic for animals has been* isolated from soil and vegetations Natural infection has been found in the internal organs of cattle sheep and dogs (Stilles and Davis 1942) *Desert rodent* have been found to be naturally infected by Emmons (1942) *These rodents* harbour the infection and act as an animal reservoir of the disease *The source* of saprophytic fungus in the desert soil is probably maintained by the infected rodents

Mode of infection Respiratory infection is caused by inhalation of the spores of the fungus in the dust carried by the wind Laboratory workers may be infected by inhalation of spores from the culture The infection is rarely acquired through the exposed surfaces of the skin

Mycology *Direct examination* In a coverslip preparation of the material the fungus appears as a thick walled doubly contoured hyaline cyst like spherules 15 to 80 μ in diameter They do not show budding in the tissues



Fig 16—(a) Culture of C mm i on S bouraud glu os ag at room t mperature weeks ol l (b) C mm t low g form t on of arthrospor in culture ( )

Culture The fungus can be grown in ordinary media or malt extract agar Colonies appear in 4 to 6 days as slightly raised membraneous disc on the surface of the slope and the growth soon penetrates through the medium In the course of another week the growth becomes downy (Fig 16a) The downs are at first snow white but with the age of the culture they become brown in colour with abundance of chlamydospores 4 to 7 μ in diameter In old cultures oval or round arthrospores are seen in abundance (Fig 16b) Old cultures are powdery friable and the spores easily borne by the air are infective

The medium recommended by Dr C E Smith contains 1 per cent each of ammonium chloride and sodium acetate 0 8 per cent tribasic potassium phosphate 0 4 per cent cupric sulphate and 2 per cent agar

Microculture Mycelia are branched and septate and the fungus forms numerous arthrospores 2 to 4 μ in diameter and separated by alternate clear and dark spaces along the course of the hypha

Animal inoculation All laboratory animals are susceptible to coccidioidal infections Mice are u ually injected intraperitoneally but guineapigs an injected intratesticularly with infected material or suspected cultures for positive results

Clinical manifestations Coccidiomycosis may affect a person of any age The incubation period is about 10 to 14 days The primary lesion may be in the skin but it often starts in the lung by inhalation of dust containing spores In the acute stage the lung infection resembles an attack of flu or bronchitis with slight fever cough headache backache and the sputum may be blood tinged This is known as the valley fever as it is common in San Joaquin valley

It is also called desert fever or desert rheumatism as arthralgia is often associated with it After 8 to 15 days nodules like those of erythema nodosum and eosinophilia may develop Recovery from the acute condition usually occurs in 3 to 6 weeks

Primary skin lesions appear as papillomatous or verrucose lesions like those of tuberculosis of the skin

Coccidioidal granuloma This is a progressive condition from this infection which develops in more severe cases of coccidiomycosis In many respects it resembles pulmonary tuberculosis as reactivation of inadequately treated cases *may occur analogous to reinfection of pulmonary tuberculosis* If the temperature of the valley fever lasts after the third or fourth week one should suspect the progressive form of the disease Then new shadows appear in the lungs when the skiagram is taken As the disease progresses dessemination occurs through blood stream with metastasis in the bone subcutaneous tissues (*cold abscess or granulomatous lesions*) internal organs including meninges Generalisation may occur in any organ with the progress of the disease with pyrexia loss of weight night sweat and the case ends fatally in 4 or 5 years

Immunity reaction Presence of precipitin and complement fixing antibodies has not been established definitely to help in the diagnosis They may appear in severe infections but disappear with recovery

Hypersensitiveness to coccidioidin develops between the second and third week of infection For the test 0 1 c c of 1 1000 of a standard antigen is injected intradermally and this should show a positive reaction Those who had previous skin infections may show a reaction even in a dilution of 1 10 000 Dickson and others hold that the cutaneous reaction is specific

Treatment No special treatment is necessary in the acute stage except rest in bed till the blood sedimentation rate is normal and lungs are found to be clear by X ray examination Complement fixation test *is negative in these* cases The prognosis is grave in progressive cases *In these cases specific* vaccine therapy has been reported *to be efficacious Iodide is ineffective X ray* therapy is helpful in causing absorption of exudate in the granulomatous process and intensive or semi intensive doses should be used Thymol has been found to be effective A 33 3 per cent solution in olive oil is applied locally and orally a daily dose of 1 to 6 gm dissolved in olive oil should be administered putting it in capsules This is administered *along with meals*

HISTOPLASMOSIS

Definition This is a rare chronic disease of the reticuloendothelial system resembling Kala azar and caused by *Histoplasma capsulatum* characterised by irregular fever hepato splenomegaly enlargement of the lymph nodes anaemia and ulcerative lesions of the buccal mucosa nose intestine anus and genitalia

History *The organism was first observed by* Darling (1906 to 1909) in section of a spleen and liver of a patient who died of a disease resembling Kala azar He called the organism *Histoplasma capsulatum* under the impression

Plate V

HISTOPLASMOSIS

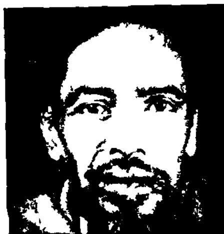


Fig 1—Histoplasmosis on the lips angles of the mouth and nose



Fig 2—Abscesses on the abdominal wall and nodular lesions on the groins

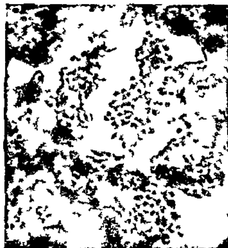


Fig 3—Section of tissue stained with Leishman's stain P E cells are packed with parasites



Fig 4—Smear stained with Leishman's stain A histiocyte is packed with *H capsulatum*

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(Courtesy of the Editor J I M A)

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Plate V

HISTOPLASMOSIS

(Continued)

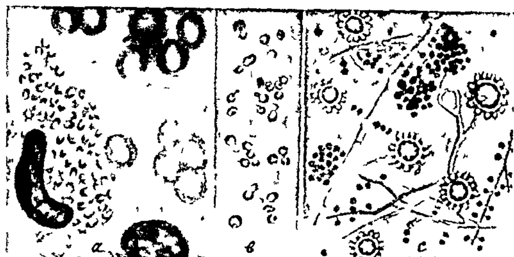


Fig 5—(a) Histiocyte laden with *H capsulatum* (b) Yeast form in culture at 37° C (c) Conidia and chlamydospores in culture

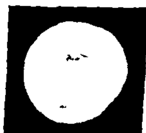


Fig 6—Culture of *H capsulatum* in Sabouraud's glucose agar at room temperature

To Face Page

that it was a protozoan Da Rocha Lima (1912 1913) observed budding of the organism and suggested that they were related to Cryptococcus Mycotic nature of the disease was finally proved by Hansmann and Schenken (1934) and DeMonbreun (1934) by culture of the organism from their cases

Geographical distribution Cases were reported from North and South America South Africa England Philippines and Java Recently one case has been reported by Panja (1954) in India (Pl V Figs 1 to 4)

Source of infection It is a naturally acquired infection in man and dog but there is no evidence that the dog is the reservoir of infection

Portal of entry The exact portal of entry is not known but it is most likely to be the oral route That the infection occurs through the oral route is evidenced by the primary infection of lips ulceration of the tongue and oral mucosa but in a few cases primary cutaneous lesions have been described Primary infections of the lung and lymph nodes have also been reported

Etiology One fifth of the cases have been recorded in infants below two years but no age is exempt Maximum number of cases are seen between 30 and 40 years of age All races are affected but nothing is definitely known about the occupational predisposition

Mycology *Direct examination* Thick and thin smears of peripheral blood sternal puncture stained with Leishman s stain show the parasite Smears from the puncture of lymph node spleen liver or ulcers of the skin and mucous membrane may be similarly stained *H capsulatum* appears as small budding oval yeast like cells which are single and 1 to 5 μ in diameter They grow in the endothelial and mononuclear cells of the body (Pl V Fig 3) They look like *Leishmania donovani* but are slightly larger than the latter kinetoplasts are absent in *H capsulatum* (Pl V Fig 5a)

Culture The organism may be cultured in common laboratory media The culture is dimorphic in character

(a) The budding or the tissue stage is seen on blood agar incubated at 37 C (Pl V Fig 5b) Primary culture appears in one to two weeks to grow but th culture should not be rejected before one month The colonies are like those of *Staphylococcus albus*

(b) Mycelial forms are seen when they grow in Sabouraud s glucose agar or Allison s copper sulphate trypsinised serum agar at room temperature The colonies grow slowly with white downy aerial mycelia at first but later they become brown with ag (Pl V Fig 6) They show septate hyphae bearing spores on short pedicles The spores which measure 2 5 to 3 μ in diameter are smooth round or pyriform In old cultures there are thick walled round tuberculated chlamydospores 10 to 15 μ in diameter (Pl V Fig 5c) The filamentous form is occasionally converted into yeast form by culturing in fresh blood agar tubes sealed (to maintain moisture) and incubated at 37 C The yeast form can be maintained by subculturing in blood agar at frequent intervals

Immunity reactions Precipitin or complement fixing antibodies could not be demonstrated in blood A delayed tuberculin like reaction becomes positive with histoplasmin in 24 to 48 hours Many workers have shown a high correlation between pulmonary calcification in nontuberculous cases and positive skin test *to histoplasmin* A large number of such cases have been detected in certain areas of United *States* indicating a benign type of endemic histoplasmosis in those areas

Animal inoculation Mice guineapigs and dogs can be experimentally infected with the cultures of *H capsulatum*

Symptoms *H capsulatum* causes infection of the reticuloendothelial system The symptoms simulate those of kala azar namely pyrexia of long duration hepatomegaly splenomegaly anaemia *leucopaenia and asthenia* Enlargement of lymph nodes may resemble lymphadenopathy of lymphosarcoma or *Hodgkin s disease* There may be ulceration of the lip tongue oral mucosa nose anus or genitalia Secondary pulmonary involvement may *simulate* one of miliary tuberculosis Ulceration of the skin has been reported The disease usually lasts for several months The mortality rate is high and the condition is often diagnosed in an autopsy

Laboratory diagnosis The parasite is found in the smear from peripheral blood sputum urine ulcers or aspirated material from lymph nodes sternum *spleen* etc The smear should be examined under 1/12 oil immersion objective after staining by Giemsa s method The smear shows small (2 to 5 μ) intracellular oval, round or apiculate yeast like cells They may be seen in mononuclear cells or occasionally in polymorphonuclear neutrophils

Cultures are made in blood agar and Sabouraud s glucose agar from pus or other materials but when the material is contaminated cultures are made on blood agar plates with 2 units of penicillin and 10 units of streptomycin per c c of the medium Culture may also be done in Allison s copper sulphate trypsinised serum agar for primary isolation

Biopsy is very helpful in the diagnosis of the disease This may be obtained from the lymph node skin mucous surface and smears and cultures should also be taken at the same time Histological study is specially meant for the study of intracellular parasites and cellular reactions The lesion is essentially a granuloma in which endothelial cells are parasitised by the organism Macrophages in the organs involved will show similar parasitisation

Treatment Compounds of antimony sulphonamide penicillin streptomycin radium and Roentgen therapy have been used but with little success

CHROMOBLASTOMYCOSIS

Definition Chromoblastomycosis is a chronic infection of the skin characterised by development of verrucose cutaneous lesions with rare metastasis in the lymph node It is caused by three species of fungi namely *Phialophora verrucosa Hormodendrum pedrosoi* and *H compactum*

History Pedroso (1911) in Brazil first observed the characteristic black bodies in a biopsy material and isolated the organism which he failed to identify Lane (1915) Medlar (1915) found spherical bodies in the lesion and isolated the fungus called *Phialophora verrucosa* Pedroso and Gomes (1920) reported four cases of verrucose dermatitis (including the original case of Pedroso) caused by *P verrucosa* but the fungus was later studied by Brumpt (1922) who renamed it *Hormodendrum pedrosoi* Terra et al (1922) named the disease caused by this fungus chromoblastomycosis Moore and Almeida (1935) however found one of these fungi isolated from four cases of Pedroso and Gomes to be *P verrucosa* The third fugus namely *Hormodendrum compactum* was identified by Carrion (1935) as the causative organism of chromoblastomycosis Carrion thus believes that there are at least three species responsible for chromoblastomycosis

Geographical distribution The disease has been reported from Cuba Puerto Rico and other parts of South America U S A and stray cases have been reported from Africa Australia Russia Canada Japan Sumatra and Java Recently one case has been reported in India by Kakoti and Dey (1957) in a woman with metastasis in the lymph node

Etiology Lesions are often seen on the exposed parts of the body commonly the feet The disease is also seen in manual labourers and wood cutters Male adults are often the victims

Source of infection In a review of 102 cases Weidman and Rosenthal (1941) found that the lesion developed following an injury by wood in some form Conant and Martin (1937)found that strains of Phialophora isolated from wood were morphologically and serologically identical with *P verrucosa* causing chromoblastomycosis in man

Mode of infection The infection is often associated with a history of injury with wood and it appears that the fungus enters into the skin and subcutaneous tissue through an injury caused by wood

Mycology Examination of the infective material (pus tissue or lymph gland) under potassium hydroxide or sodium sulphide solution shows thick walled single double or multilocular cells 6 to 12 μ in diameter (Pl VI c d and g) Different species can be identified in cultures

Culture Exudate pus or biopsy material may be utilised for this purpose The material is inoculated in Sabouraud glucose agar and incubated at room temperature The cultures are kept at least for 4 weeks before they are discarded as negative

CULTURAL CHARACTERS *H pedrosoi* and *P verrucasa* are slow growing felt like dark brown or olive black growths whereas *H compactum* shows a heaped up greenish or dark olive green colour (Pl VI h) On microscopic examination of mounts in lactophenol mycelia are 2 to 3 μ in diameter and brown in colour In *H pedrosoi* three types of spores are seen (Fig 17)

(a) *Hormodendrum type* These are characterised by conidiophores bearing chained codidia which are brown single celled and branching in character (b) *Acrotheca type* In this conidiophores develop terminally or as single lateral

branches on aerial mycelia The conidiophore is club shaped from which conidia sprout on short protuberances (c) *Phialophora type*—This is characterised by flask shaped conidiophores (phialides) containing masses of conidia *H compactum* is differentiated from *H pedrosoi* by its terminal and lateral conidiophores which bear subspherical conidia in compact masses (Pl VI i) *P verrucosa* is characterised by phialophora type of conidia but occasionally hormodendrum type of conidia are seen

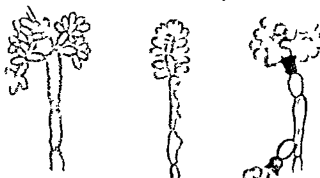


Fig 1 Left—Hormodendrum type middle—acrotheca type and right—Phialophora type of conidiophore

Histopathology (Pl VI e) The epidermis undergoes hyperplasia and hyperkeratosis with acanthosis and elongation of rete pegs A granulomatous lesion is seen in the corium forming pseudotubercles formed by epitheloid cells and Langhans type of giant cells Surrounding the granuloma are lymphocytes plasma cells eosinophils and a few neutrophils The multilocular spores separated by septa are seen in the giant cell or in the abscess The size of the cell is 5 to 10 μ in diameter They appear as dark brown thick walled cells separated by septa but without any evidence of budding as in the case of blastomycosis They reproduce in the tissue by septation (Pl VI c d and g)

Signs and symptoms The lesion is often unilateral usually on the foot or leg It starts as a papule or pustule which gradually develops into a verrucose or cauliflower like growth Satellite lesions develop along the lymphatics in close proximity to the primary lesion till the whole foot or the whole limb is involved (Pl VI b) Elephantiasis may result from fibrosis and lymph stasis (Pl VI a) Metastasis to the regional lymph gland is rare

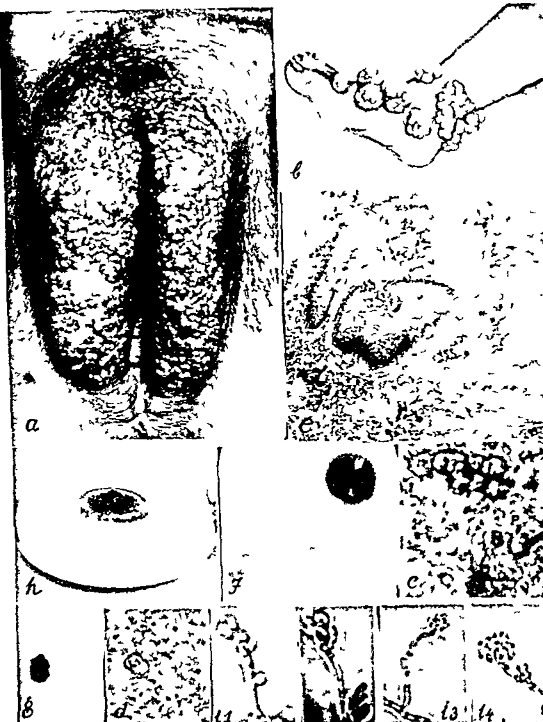
Immunology Complement fixing antibodies have been demonstrated in the serum of the patients suffering from chromomoblastomycosis But the test

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Explanation of Pl VI Chromoblastomycosis (a) Verrucose condition of the ... (b) Affection of the leg and foot (c and d) Spores in tissue (KOH preparation) (e) Histopathological section showing an epidermal abscess formation (f) Same under oil immersion showing a pair of spores (g) Spore in pair after disintegration of the lymph node in KOH solution (h) Culture in Sabouraud's glucose agar ... Conidia of *H comp...*

PLATE VI

CHROMOBLASTOMYCOSIS



To Face Page

is of little diagnostic value as the fungus is easily demonstrated in the smear culture or biopsy material Conant et al 1937 have demonstrated that the serum of the patient infected with *H pedrosoi* fixes complement in presence of *H pedrosoi* and *P verrucosa* but there is no cross fixation of complement with other pathogenic fungi or plate contaminants of the genus Hormodendrum

Animal inoculation No laboratory animal has been found to be susceptible in our hands to *H compactum*

Laboratory diagnosis This can only be done by finding of the fungus either in smear culture or biopsy material

Treatment Small isolated lesions may be excised surgically or treated by electrocoagulation Sodium iodide is administered intravenously supplemented by potassium iodide by oral route Sulphonamide acts in combating secondary infections and for this sulphamerazine should be tried since this has been found to be effective *in vitro* Success has been reported in iontophoresis with copper sulphate

CANDIDA ALBICANS (Robin) Berkhout 1923
Genus Candida

History Langenbeck (1839) demonstrated a yeast like fungus in the lesions of thrush which was named by Robin (1853) as *Oidium albicans* The organism was called by Zopf (1866) *Monilia albicans* Castellani (1905) found it as the causative organism of bronchomoniliasis The generic name Candida was suggested by Berkhout (1923) to include fungi which reproduced by budding and developed pseudomycelia Since then a number of species was included in this genus An excellent review of yeast like fungi was given by Skinner (1947) The generic name Candida was supported by Dodge (1935)

General characters The genus Candida is characterised by yeast like fungi which reproduce by and form septate budding mycelia whereas torula reproduce exclusively by budding without formation of mycelia It differs from Saccharomycetes or true yeasts by presence of its mycelia which are absent in true yeast On the other hand members of the genus Candida do not show ascospores seen in Saccharomycetes The morphological counterpart of the genus Candida in the class Ascomycetes is Endomycopsis which shows not only mycelia and budding but ascospores also (Fig 7)

SPECIES There are several species of Candida found in nature and the common species that are commonly seen are *C albicans C tropicalis C pseudo tropicalis C krusei C parakrusei C stellatoidea* Of these *C albicans* is found often as a parasite and occasionally as a saprophyte It is also pathogenic to rabbits Many other species of Candida are mostly seen as saprophytes and are not pathogenic to rabbits For this reason the modern trend amongst the mycologists is to accept *C albicans* as the common pathogenic species

Morphology *C albicans* is a small budding yeast like fungus 2 5 by 4 to 6 μ In the exudate sputum and mucous membrane budding and pseudomycelial forms are seen by elongation of thecells and rarely the mycelial form Mycelial forms are best seen in cultures showing clusters of

spores (Fig 18a) *C albicans* in culture is differentiated from other species by the presence of chlamydospores which develop best in corn meal agar (Fig 18b) Spores are often seen in the infected skin (Fig 19)



Fig 18—(a) Blastospores in culture (b) Chlamydospores and blastospores in corn meal agar

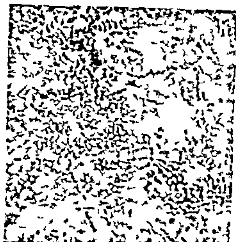


Fig 19—Spore of *C albicans* in scales

Cultural characters *C albicans* grows easily in Sabouraud s glucose agar at the room or incubator temperature in about 48 hours The colonies are yeast like white or cream coloured and emit a peculiar yeast like odour Giant colonies when old show honeycomb appearance in the centre and may show radial furrows (Fig 20)

Biochemical reactions It ferments glucose and maltose with production of acid and gas It does not ferment lactose but ferments sucrose with production of acid only Differentiation of *C albicans* from other nonpathogenic species is shown in table V

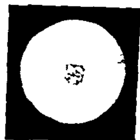


Fig 20—Giant colony of *C albicans*

Animal inoculation Intracutaneous inoculation in guinea pigs causes local abscess formation in 48 hours Intravenous injection of 1 c c of a one per cent suspension of the growth in rabbits produces miliary abscesses in the kidney and other parts of the body and kills the animal in 4 or 5 days

Immunity Sera of individuals showing moniliasis often show agglutination with saline suspension of *C albicans* but others also may show agglutination in low titres Positive results are seen by skin tests with oidiomycin but it is of doubtful diagnostic significance as presence of the organism in the mouth and gastrointestinal tract of apparently healthy individuals may account for both agglutination and skin sensitivity tests

MONILIASIS

Definition Moniliasis is an infection caused by a yeast like fungus *C albicans* affecting the mucous membrane of the mouth (thrush) intestine

TABLE 1 DIFFRENTI\L DIAG\OSIS OF SPECIFS OF C\\DID\

(After Martin et al J Bact 34 99 1937)

Species	Sabouraud aga and broth	Colony charact		Glucose	Maltose	Sucrose	Lactose	Pathogenicity
		Blood agar	Corn meal agar					
C alb	Typical creamy growth no rf ce growth	Dull gr v m l m siz ed colon es	Tr e like b anch l mycel a w th term l chlamy lo po e	AG	AG	A	—	Patho genic
C t p l s	Not cl a a te stic th n rf ce film	G ey l white large colon es with myce lial f i ge	T u my lia w tl well d ve loped Bla to pores but no hlamydos po es	At	At	AG	—	Non pa thogen
C p d t picol s	Not cl a ac teri t no su face growth	Small colo nies not cha ta stic	Myc l um poorly deve loped chla mydo pores al nt	AG	—	A(	AG	Non pa thog n c
C k	Flat dry gr wth w d surf ce f lm	Small d ll gray colon —not charac t rist c	Cros ed st cks my c l a no cl lamydo spores	AG	—	—	—	Non pa thog nic
C p k	C amy growth no su face g owtl	Small bri ll ant white colon	Well de e loped myce- l a no chl mydo pores	AG or A	—	—	—	Non pa thog n c
C t llat d	C e my growth no s f e growth	Star l ke clonies with rad ating arm	Myc l a with larg ball like lusters of bla to spore	AG	AG	—	—	Non pa thog n c

AG = Acid and gas A = Acid — = No fermention

vagina (vaginitis) mucocutaneous areas angular chelitis skin (dermatitis) and nails (Paronychia) and bronchopulmonary affections It may rarely produce meningitis or other generalised infections of the body affecting the liver spleen lymph nodes etc

Etiology The affection is seen in the tongue or buccal mucosa of infants or old people or of debilitated persons suffering from wasting diseases like tuberculosis cancer or diabetes Lesions are also seen in people suffering from angular chelitis due to vitamin B complex defieciency and in sprue Lesions on

the hand and nails are seen in housewives whose hands are macerated frequently by soaking in water and also in bakers and fruit sellers

Transmission *C albicans* is seldom isolated from natural substrates (Skinner 1947) The infection is often of endogenous origin The organism is naturally found in the mouth or intestinal tracts of a large percentage of normal human subjects The skin and nail infections may occur from those sources provided the moist condition is present Infants probably contact oral infection from the birth canal Cutaneous moniliasis of the nipple of the nursing mother is caused by the organism of the oral thrush

Signs and symptoms *C albicans* causes moniliasis of the nail, skin mucous membrane, bronchopulmonary monailiasis and rarely moniliids

Paronychia (Pl VII b c and e) It is an infection of the base of the nail due to constant maceration of the tips of fingers and toes characterised by bolster like swelling of the tissue about the bases of the nail frequently seen in housewives The affected nails show transverse ridges thickening and distortion (Pl VII Figs c e and g)

Erosio interdigitalis blastomycetica The fungus is apt to cause infection of the skin of the intertriginous regions namely webs of the fingers (Pl VII a and g) and toes folds of breast axillae inguinal and intergluteal regions The skin is found to be sodden and macerated in the affected areas and scraping shows a large number of the organism

Perleche (Pl VII d f and h) It is often seen in cheilosis due to vitamin B complex deficiency There is soddening of the angles of the mouth with signs of erosion

Thrush *C albicans* causes thrush specially in marasmic children The mucous membrane of the tongue buccal cavity pharynx tonsils and gum show a scum grayish white in colour The patches can be removed easily with a gauze The infection probably occurs from the birth canal of the mother at the time of birth of the child The perianal region of the infant may be found to be infected in cases of oral thrush

Vaginitis Vaginitis caused by *C albicans* is not uncommon during pregnancy It may set up vaginal discharge as a result of inflammation caused by the fungus It may also set up a condition of pruritus valvae particularly in diabetic subjects

Bronchopulmonary moniliasis The fungus may cause a condition of bronchitis which often extends to the lungs Cough and dyspnoea are the most distressing symptoms and haemoptysis may occur in certain cases The sputum is mucoid and gelatinous and contains gray flakes of mycelia and detritus Chest signs are those of bronchitis Castellani has described three clinical types The *mild type* is usually afebrile but in the *intermediary type* there is slight rise of temperature Recovery may be spontaneous or the disease may progress to the *severe type* and end fatally with cough haemoptysis hectic rise of temperature and emaciation At this stage it resembles tuberculosis of the lung In the pulmonary type it may produce patchy bronchopneumonia or it may

PLATE VII

MONILIASIS



(a) Int d ɑ tal aff t on —e osıo nterdıg tal blastomycet ca (b c and) Pa onych a (bolst r l ke swell g) (d f and h) Mon l as a soc at d v th ch l (g an l e) Deform ty of the na l w th t ansve se st t ons ın ase of paronychia

involve one or more lobes with evidence of consolidation and pleural thickening The condition of generalised moniliasis is rare in pulmonary moniliasis

Radiologically the condition shows nonspecific type of peribronchial thickening with a hazy type of linear fibrosis

Moniliids These are sterile vesicular grouped secondary lesions with erythema and may appear on the body as a result of dissemination of the fungus in the blood Primary focus may be seen in other parts of the body either in the skin or gastrointestinal tract

Diagnosis It depends on the finding of the fungus from the scraping of the skin nail mucous surface or in the sputum or stools

Direct examination of the scraping of the skin shows spores in large clusters and a few mycelia if any (Fig 19) whereas direct examination of the scraping from the mucous surface under a coverslip preparation with McGuire s stain shows mycelia with budding cells stained purplish blue *Culture* from various lesions shows almost a pure culture of *C albicans* in Sabouraud s medium Diagnosis of the infection of the lung is confirmed by isolation of the organisms from the sputum constantly and in large numbers *Presence of antibodies* in the serum namely agglutinin in high titre precipitin or complement fixing antibodies are suggestive of infection with *C albicans* but it is difficult to say whether there is any primary infection or not as low titre of these antibodies may be found even in intestinal conditions without any symptom

Treatment In valvo vaginitis glossitis and mucocutanous infeetions local application of gentian violet is advisable But along with the local treatment administration of vitamin B-complex and adexoline in children are very good adjavants In erosio interdigitalis blastomycetica or paronychia application of lotio gentian violet or triple dye is useful and when continued for some months the condition heals up completely Application of Pot permanganate 1 4000 is useful in local lesions In bronchopulmonary moniliasis Pot iodide may be administred upto the dose of tolerance Ethyl iodide insufflation has been used successfully in these cases but hypersensitive cases should be desensitised before administration of iodide (See blastomycosis) Intravenous injections of gentian violet (5 mg per kilogram of body weight may be administered daily or every other day Solutions stronger than 0 5 per cent should not be administered intravenously as there is chance of thrombosis in such a case

TINEA VERSICOLOR AND *MALASSEZIA FURFUR*

Synonym Pityriasis versicolor Tinea flava tinea nigra etc

Definition The disease is characterised by scaly lesions of the face and body and associated with hypopigmentation and discolouration of the skin of the affected parts

Etiology The disease is common in young adults of both sexes but it is more common in males than in females It is rare in children In the winter season the disease may remain latent but with the advent of the summer there is

a rapid spread of the disease. This can be explained owing to excessive perspiration as hyperidrosis often predisposes to it.

Mycology. *Malassezia furfur* is the causative organism of tinea versicolor. *Direct examination.* The fungus can be demonstrated in the scales under a coverslip preparation with caustic potash but better results are obtained with McGuire's stain which stains the spores and mycelia purple (Pl. VIII). When properly prepared the affected scales can be identified under the low power and under the high power characteristic morphology of *M. furfur* is seen namely (a) groups of spores with double contour, (b) mycelia which are short stout sinuous often septate with blunt ends and occasionally branching.

Culture. There is a conscientious of opinion whether the organism can be cultivated but the author is of opinion that the organism can be cultivated in the same way as that of *P. ovale* (Method of Panja). From the primary growth subcultures may be obtained in glucose or glycerol agar containing sterile olive oil spread on the surface of the slope. Budding forms are frequently seen in the culture. The organism has great similarity with *P. ovale* and their difference is shown in Table VI.

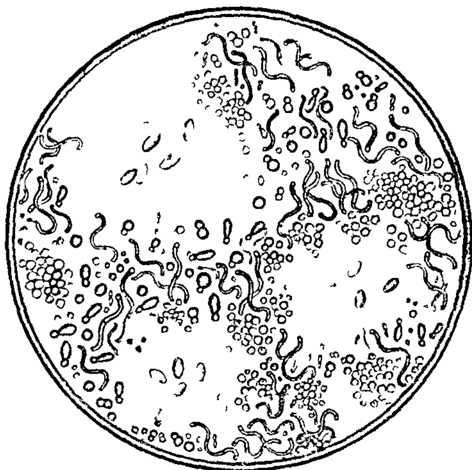
TABLE VI—COMPARISON BETWEEN *M. FURFUR AND P. OVALE*

Particulars	*M. furfur*	*P. ovale*
Microscopical (McGuire's stain)		
Mycelia	Always present	Rare
Budding	May be present	Always present
Spores (Double walled)	Plenty	Absent
Culture		
Growth	Difficult to grow on ordinary media	
Petroff's medium	Heaped up chalky in appearance	
Oil media	Heaped up glabrous growth	

Signs and symptoms. The disease starts as tiny hypopigmented scaly macules on the face, chest, neck, back or abdomen. The macules coalesce and form hypopigmented areas which exhibit a wide diversity of shape and size. On close observation the macules often gyrate due to coalescence, are seen to be covered with shiny scales and show yellowish brown or dark colour in contrast to the healthy skin. According to the colour they have been variously called tinea flava, tinea alba or tinea nigra. The condition is non inflamatory and does not produce any subjective symptoms except a little irritation or discomfort specially when exposed to the sun. The disease causes mottled disfigurement

Plate VIII

MALASSEZIA FURFUR



Scales of Tinea versicolor (McGuire's stain) showing spores in cluster and mycelia scattered irregularly budding forms are also seen Some of the cells are nucleated (Parakeratosis)

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Plate IX

TINEA VERSICOLOR

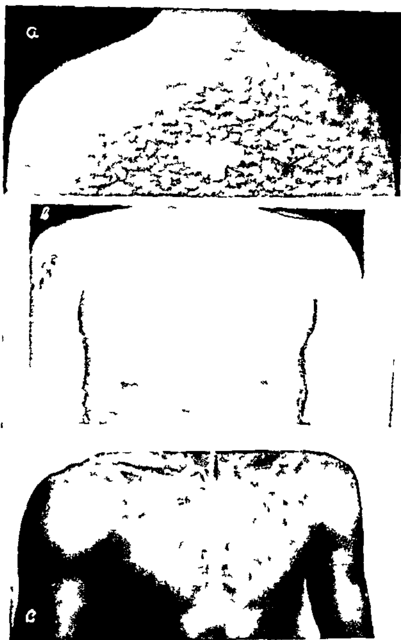


Fig (a)—back (b) and (c)—upper part of the chest

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of the neck face and trunk (Pl IX a b c) and interests the patient mainly from the aesthetic point of view The affected parts show fluorescence under the Wood s light

Diagnosis This can be done directly by examination of the scale scraped from the lesion When McGuire s method is used the morphology of the stained fungus can be very well studied namely groups of spores and mycelia Indirectly the condition can be diagnosed by demonstration of fluorescence under the ultraviolet light passed through Wood s filter and the colour may vary from a light to dark brown according to the degree of discolouration

Differential diagnosis Hypopigmented macules are often confused with (1) Dermal leishmanoid (2) Neuromacular leprosy

(1) Dermal leishmanoid Hypopigmented macules of dermal leishmanoid are erythematous rather than scaly Scrapings donot show presence of *M furfur* Characteristic feature of dermal leishmanoid is that the granuloma more often affects the mask area of the face with an erythematous flush In well advanced cases small nodules may be present specially on the chin In case of dermal leishmanoid the patient always gives a history of kala azar Smears from the erythematous hypopigmented lesions donot usually show *Leishmania donovani*

(2) Neuromacular leprosy * In this condition there is always partial loss of pigment as in a case of tinea versicolor The patch is hypopigmented and anaesthetic but rarely there is hyperaesthesia or parasthesia Deep analgesia is often present The scraping from the lesion does not show any fungus

Treatment Sulphur in any form will effect a cure (for details see seborrhoea) To avoid recurrence personal cleanliness is essential and under wears or garments coming in direct contact with the skin should be changed and boiled daily to avoid reinfection Pulv Sulphur et camphor is very useful in cases of profuse perspiration

REFERENCES

Cryptococcosis

Benham R W Cryptococci—The r ident fi ation by morphology and by serology *J I f t D* 57 ‿5 1935

Busse O Ueb r Saccha omycos s hominis I *h A h f p th* t 140 3 189‿

Stoddard J L and Cult r F C To ula inf ct on in man *R k f ll I t t t fo M d l R h* Monograph 6 1916

Vu llem P Le caracter s sp c f qu du hamp gnon du mugu t *C mpt d* 127 630 1898

Pityrosporum ovale and Seborrheic dermatitis

Acton H W and Panja G Seborrheic d rmatitis o p tyrias cap t Le ion caused by *M las v le Ind M d G* 62 603 19

B nham R W Cultural chara te stics of Pityro porum ovale—lypophytic fungus *J I t D rm t* 2 187 1939

Emmons C W Isol tion and pathogen ty of *P ty p m l P b H lth R p* 55 1306 1940

MacLeod J M H and Dowl ng G B Exper m ntal tudy of Pity osporon of Mala se M rphology cult at on a d pathog n ty *B t J D m t* 40 139 19?8

* According to mod rn cla fi t n it s called ind t m nat o b derl n group of lep o y

Malassez L Note sur l champignon de la pelade Arch de phys l n m t p th l 1903 18 4

Moore M Cultivation and study of pityrosporum ovale the so call d bottl bacillus of Unna Arch D m t & Syph 31 661 1935

——Kile R L Engman M F Jr and Engman M F L Pityrosporum ovale (Bottl bacillus of Unna spore of Malassez) Cultivation and possible role in seborrheic d rmatitis Arch Dermat & Syph 33 4 19 6

Ota M and Huang P Sur l s champignons du genre pityrosporum Sabouraud Ann de parasitol 11 49 1933

Parja G Tr ns ti n of the F r Easte n As ciati n of T opi l Medic l 4 18

Blastomycosis

Gilchrist P C A case of Blastomycetic d rmatitis in man R p J h Hopkins Ho p 1 269 1896

Gilchrist T C and Stokes W R A case of pseudo lupus vulgaris cau d by Blastomyces J Expe Med 3 53 8 1898

Ricketts H T Oidiomycosis (blastomycosis) of the skin and its fungi J M d R sear h 1 373 1901

South American Blastomycosis

De Almeida F Blastomyco of Brazil Ann Fac de med d São Paul 9 69 1933

Fonseca O da Jr Etiologic agent of n otropical blastomycoid granulomatosi A B asil de l m t e sif 14 85 1939 English translation pp 119 13

Lut A Uma Mycose Pseudococcidica Locali n la na bocca e ob s r ada no Brasil B a l M l o 22 121 141 1908

Splendore A Sobre um novo caso de blastomycos generalizada R sci S o Paulo 4 5 1909

Coccidioidomycosis

Emmons C W and Ashburn L L The Isolation of Hapl p g m j m n Sp and C i l les Imm t from wil l ro l nts their relationship to c ci l oido mycosis Pub H lth Rep 57 1 1 194

Ophuls W and H C Moffitt A new pathogenic mould (form rly des rib l a protozo n C cc l o les immitis py g ne) Ph la M l J 5 14 1 1900

Rixford F and Gilchrist T C Two ca s of protozoan (Cocci lioi l l) inf ct n of tl skin R p Johns H pk ns H sp 1 09 1896

Smith C E Epidemiology of the acute co c l idomy os s w th rythema n lo u Am J p b H l h 30 600 1940

——Parall l m of coc ioi l an l tul cul sis inf tion R l l v 38 1 1 1

——Cocc l oi l myc s M d Cl ic N Am t pp 30 10 1943

Stil s C W and C I Davis Cocc dio l l granuloma (c c ioi lomyc) J Am M d As c 119 t 1 4

Wernicke I Ueber einen Protozoenbef in l ei mycosis fungoi l s C t lbl f B kt 12 85 18

Histoplasmosis

Con nt N F Cultural st dy of the life cy le of H t pl m c p l t m D rl g 1 J B t 41 13 1 41

Darling S T A protozo n g n r l infection producing p eudot ber l s n l f al necro is in liver spl n and lymph no le J A M A 46 1 83 1906

De Monbreun W A Cultivation and cultural characteri ti of D rl ng H t pl m c ps l t m Am J Tr p M d 14 93 1934

Han mann C H and S h nken J R A unique infecti n in man au sed by a n w yeast like organi m a pathog ni m mber of the g nu S p l n um Am J I th 10 31 1934

P nja C and Sen S A u iq i ca e f H to pla mo i J I d M d A 23 1 4

Chromoblastomycosis

Brumpt F *I e dep t l g e* Masson et Cie Paris 3rd e l p 110(19?

Carrion A L Chromoblastomycosis Preliminary report of a n w cl nical type of the di ease cau e l l y *H rm d d m mp t m* Nov sp *Pu t Ri J Pub H lth T p M d* 10 343 1935

Conant N F and Martin D S The morphologic and serologic relationships of the var ous fu gi cau ng dermatitis verrucosa (chromoblastomycos s) *Am J Tr p M d* 17 553 193

Emmons C W and Ca rion A L The Phialoph ra type of sporulation in *H rmod drum comp t m P rt r J P b He lth T p M d* 11 03 1936

Kakoti L M and Dey N C Chromoblastomyco is in Ind a *J I d M d A c* 28 3 1 19

Lan C G A cutaneous d se e caused by a new fungus (*Phal ph verruc*) *J C t n D s* 33 840 1915

Medla F M A new fungus *Ph l ph a v rr c s* pathogenic for man *My ol gi* 7 00 1915

Pedroso A and Gomes J M Sobre quatro cases de dermatite verrucosa produzida pela *Ph l ph v An p l t med c g* 9 53 1 1 0

Wei lman F D and Ro enthal L H Chromoblastomycosis new and important bla tomyco in North Am rica *A h D m t Syph l (Ch g)* 43 6 1941

Terra F Torr s M Fonseca O Da and Lesoi A F A *B l M d* 2 363 19

Mon liasis

Be khout C M De S h mmelgeslachten Monilia O l m Oo pora en Torula Edauw & Joh nnissen Scheveninq n 19 3

Le genbeck B Neue Notiz n aus dem Cob ete der Natur und He lkund (Froriep) 252 145 1839

Robin C Histoir natu elle d veg taux pa t s q u croi sent sur l homme et sur an m u vivant J B Ba ll re Pari 18 3

Sk nn C F *B t ol g l Rev e* 11 2 7 1J4

Z pf W Die P l E T wen lt B sl u 1890

Dodge C W M d cal Mycology Fungus d s of man and other mammals C V Mo by Comp ny St Lou s 193

CHAPTER VI

SUBORDER BLASTO ARTHROSPORINEAE

Order Thallosporales Vuillemin 1910

GEOTRICHOSIS

Definition It is a condition caused by *Geotrichum candidum* affecting the skin mucous membrane gastrointestinal tract infection of the lung simulates chronic pulmonary tuberculosis

History *G candidum* was isolated from leaf mould by Link (1809) This was often called *Oidium* or *Oospora lactis* The term Oidium means the imperfect stage of certain fungi of the class Ascomycetes the powdery mildews parasitic on plants However to give effect to priority the species is called *G candidum* and this term has already become popular in the field of mycology

Habitat This occurs in the soil as a saprophyte and has also been isolated from stools and lesions in the human body

Mycology *G candidum* appears in the form of arthrospores which are characteristically rectangular 4 to 6 μ by 8 to 12 μ in size Thick walled ovoid or round cells may form a chain of arthrospores Rounded forms may be mistaken for Blastomycetes but presence of arthrospores in chains is diagnostic of Geotrichum

Culture The organism grows quickly in Sabouraud s glucose agar either at room temperature or at 37 C The growth is membraneous and in about 7 to 10 days colonies form They are flat white to cream coloured soft to the touch of the loop like yeast colonies and can be picked up easily In liquid media it forms a surface membrane

Microscopically arthrospores are round or rectangular in shape They give out germ tubes but do not reproduce by typical budding

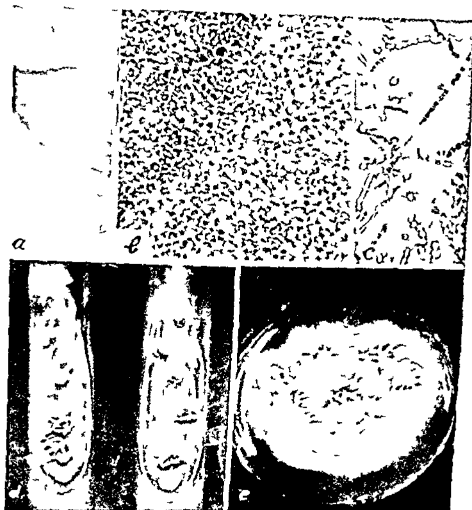
Biochemical reaction Most of the strains liquefy gelatin and produce acid in certain sugars Some strains coagulate milk

Symptoms It may produce a condition of bronchitis with persistent cough The sputum is often grayish but it may be blood stained occasionally X ray examination shows peribronchial thickening The general health of the patient is however not affected Infection of the lung may simulate chronic tuberculosis Oral geotrichosis resembles thrush caused by *Candida albicans*

Treatment Potassium iodide by mouth and sodium iodide intravenously have been successfully used in cases of pulmonary geotrichosis

PLATE X

TRICHOSPORUM BEIGELII



(a) Nodosity of the hair (low power) (b) Same under high power mag [illegible] (c) Hanging drop culture showing arthrospores in chain (d) Growth of *T beigelii* on Sabouraud's medium—three weeks old (e) Giant colony six weeks old

PIEDRA

Synonyms Black piedra White piedra Tinea nodosa Beigel s disease etc

Definition Piedra is a fungus infection of the hair of the scalp mustache or other hairs of the body caused by *Trichosporon beigelii* producing white, nodules easily detachable from the hair and *Piedraia hortai* producing black piedra forming hard nodules firmly adherent to the hair The condition is contagious

History The disease was first described by Beigel (1865) in Germany forming nodules on the hair of wigs Behrend (1890) described *Trichosporon ovoides* recovered from the hair of the scalp in Germany Vuillemin (1902) found light coloured nodules on the moustache and called it *T beigelii* Black piedra was originally described by Dessene (1878) Horta (1911) studied black piedra of the hair in Brazil and Fonseca and Leão (1928) called it *Piedraia hortai* According to the work of McKinnon (1942) black piedra in Brazil is due to *P hortai* white piedra in South America is due to *T beigelii* other species namely *T giganteum* Unna 1895 *T ovoides* Behrend 1890 *T glycophila* Dubois 1910 etc fall synonymous with *T beigelii* (Rabenhorst) Vuillemin 1902

Geographical distribution White Piedra occurs in South America central Europe England and Japan Dey and Kakoti (1954) reported a case of white Piedra in Assam Black piedra has been reported in Columbia and other countries of South America and from East Indies Java and Kochin China

Etiology *P hortai* infections are seen in epidemic form more often in the moustache of man than in the long hair of woman

Mycology *Direct examination* *T beigelii* forms a mass of gelatinous mycelial spores composed or round or oval cells In a coverslip preparation with sodium sulphide the arthrospores are found to from 3 to 10 μ in diameter The fungus reproduces by arthrospores and also by budding and both the elements are held together in a gelatinous substance (Pl X a b) In a coverslip preparation with sodium sulphide solution nodosities of the infected hair in case *P hortai* contain round or polygonal cells They form dark hard adherent mass formed by broad closely septate hyphae branching dichotomously Numerous oval asci 30 by 50 μ are seen containing eight curved or fusiform ascospores 10 by 30 μ having simple terminal cilia like appendages

Culture On Sabouraud s medium *T beigelii* grows faster and forms a soft brittle cream coloured wrinkled colonies (Pl X d e) They show thick double walled amthrospores forming chains (Pl X c) On Sabouraud s glucose agar *P hortai* forms a slow growing greenish black glabrous growth hard to touch nodular or wrinkled in appearance

Pathogenicity *T beigelii* causes sporadic infection of the long hair of the scalp and is much less contagious than *P hortai* whereas *P hortai* affects the coarser hair of the beard ans moustache rather than the scalp hair

Treatment The hair should be cropped close to the crown or shaved and lotio hydrarg perchloride (1 2000) or Ung Hydrarg ammon (3 per cent) should be applied on the scalp Lotio resorcin is equally efficacious in this condition

REFERENCES

Geotrichosis

Link *Ma Ges Natur Fruende Berlin* 3 17 1809

Piedra

Behrend G Ueber Trichomycosis nodosa (Juhel Renoy) Piedra (O orio) 27 464 1890

Dey N C Kakoti L M White Piedra in India *Ind Jou Med Science* 9 344 1955

Fonseca O Da Jr and Area Leão A E de Sobre as cogumelos da pietra brasilara *Mem Inst Oswaldo Cruz* suppl 4 174 1938

Horta P Sobre uma nova forma de piedra Mem Inst Oswaldo Cruz 3 87 1911

Mackinnon J E and Schouten G B Investigaciones sobre las enfermedades de lo cabellos denominadas piedra *Arch de la soc d Biol de Montevideo* 10 ° 194



SUBORDER ARTHROSPORINEAE

Definition These are Thallosporales which reproduce by arthrospores

Classification Genus Madurella Brumpt 1905 producing black mycetoma
Genus Indiella Brumpt 1906 producing white mycetoma

GENUS MADURELLA Brumpt 1905 emendavit Pinoy 1912

Definition and general characters These are Arthrosporineae characterised by sterile septate hyphae which reproduce by arthrospores often secreting a black pigment These are generally found in black mycetoma and grow well at 37 C The type species is *M mycetomi* Laveran 1902

MADURELLA MYCETOMI Laveran 1902

Geographical distribution Carter's black grain mycetoma is found in India Africa Somaliland Senegal Madagascar Algeria one case has been reported from Italy

Morphology and cultural characters The filaments are 1 to 4 μ in diameter and the arthrospores which are formed by grey hyphae are 3 to 10 μ Each of the arthrospores divides to form two spores which are of the same diameter of the hypha from which they arise the membrane becomes yellowish with age Chlamydospores may be 10-12 μ in diameter intercalary or terminal at the end of filaments like favic nails (Fig 21)

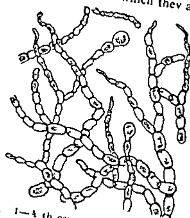


Fig 21—Arthrospores and chlamydospores of M mycetomi

Culture They form black sterile sclerotes 0 5 to 1 mm often formed in the depth of the medium

Pathogenicity The organism cause Carter's black mycetoma in man invading the skin muscles bones and connective tissues They form granulomas with grey or black granules 1 to 2 mm in diameter the granules are hard brittle round and warty often resembling the sclerotes in culture media

MADURELLA TOZEURI Nicolle and Pinoy 1908

In the lesion they show mycelial elements with yellowish membrane 1 to 4 μ in diameter They often give a speckled appearance in sugar media but rarely with any sclerotia formation

Pathogenicity They produce mycetoma in man with amorphous black grains The granules are not more than 1 mm and resemble those of Carter s mycetoma The granuloma is often associated with giant cell formation The pigment is formed by tryrosinase

GENUS INDIELLA Brumpt 1906

Definition and general characters These are Arthrosporineae with septate branching hyphae without any pigment forming white or yellowish small granules Mycelial threads are 1 to 8 or 10 μ in diameter Masses of mycelia form sclerotia like bodies or grains containing chlamydospores in the tissues of men and animals Mycelia are known only in the parasitic life and has not yet been cultivated Filaments are 3 to 5 μ in diameter septate ramified septa are seen at a distance of 5 to 10 μ In grains, chlamydospores are seen most often terminal and the sizes vary from 5 to 12 μ in diameter sclerotes are small about one fifth of a mm Type species *Indiella mansoni* Brumpt 1906



Fig — Sclerotia of *I reyni* coiled in vermiform masses

Classification On the basis of sclerotia Indiella are classified as follows —

1 Sclerotia hard and bean shaped—*I mansoni* causing Brumpt s white mycetoma in India and China

2 Sclerotia soft and coiled in vermiform masses—*I reynieri* causing mycetoma in France and Greece (Fig 22)

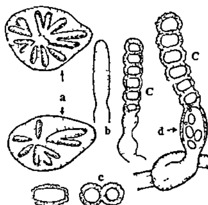
A third species has been described in Brazil—*I Brumpti* Piraja da Silva 1922



ORDFR HEMISPORALFS Vuillemin 1910

These ire Hyph iles (Hyphomycetes) which reproduce b) hemispores Hyphae are thin but more that 1 μ in diameter conidiophores are septate and branched each hemispore consists of a branch terminating in an ampuliform protoconidum preceded by an annular constriction (Fig 23 b) I rotoconidium divides partially or completely into several spore like segments deuteroconid i (Fig 23 c) occasionally however it elongates forming a new conidiophore After rupture of the tubal wall conidia remain adherent for a short period to the tubal membrane and are then set free The conidia are rough subspherical oval or barrel shaped and thick walled

HEMISPORA STELLATA Vuillemin 1906



F g ?3—(a) Growth of *H* *i ll t* on Sat ourau l e med um (b) Prot coni l a ( ) Deute ocon d a (l) Format on f d uteroconi l a

H stellata produces indolent gummatous ulcers like those of sporotrichosis Cold abscesses or osseous lesions are sometimes produced as in tuberculosis or in tertiary syphilis It is pathogenic to man and was first found by Gougerot and Caravan (1909)

Culture The culture shows white stellar discs covered with conidiophores Deutero conidia are subspherical or barrel shaped 2 6 to 3 5 μ with dark cloured granular membrane (Fig 23 c) Culture grows well on sugar media at room temperature

Treatment Treatment with potassium iodide gives good results

——x ——

CHAPTER IX

ORDER CONIDIOSPORALES

They reproduce by conidia which may be microconidia (aleuriospores) or true conidia borne on sterigma

SUBORDER ALEURIOSPORINEAE

Definition Organisms of this group reproduce chiefly by aleuriospores or microconidia Many of the species show formation of fusiform macroconidia Dermatophytes and the genera Glenospora and Acladium fall into this group

TABLE VII DERMATOPHYTES OR RINGWORM FUNGI

Genus	Species
1 Microsporum	*M audouini*
	M canis
	M gypseum
Trichophyton	
Rubrum group	*T purpureum (T rubrum)*
Crateriform group (Endothrix)	*T tonsurans*
	T sulphureum
	T [illegible]
Gypseum group (Ectothrix small spore)	*T mentagrophytes*
Rosaceum group (Ectothrix large spore)	*T rosaceum*
Faviform group	*T schoenleini* and other varieties
	T concentricum
	T violaceum (Endothrix)
	T discoides (Ectothrix large spore)
3 Epidermophyton	*E floccosum*

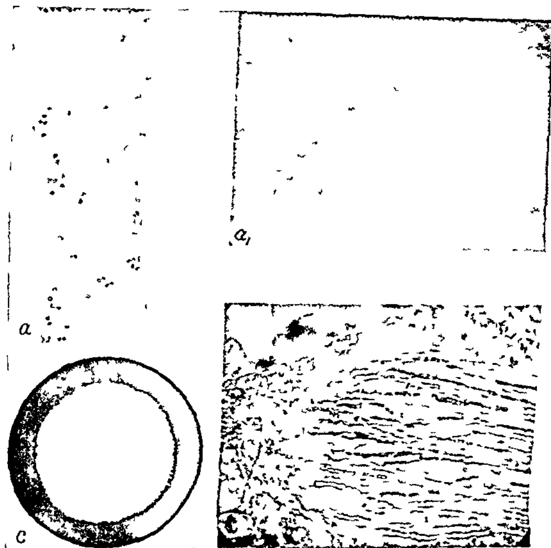
Genus Microsporum Gruby 1843

General characters Ringworm fungi of this group cause tinea capitis in children and the glabrous skin may be secondarily affected The animal species may cause kerion The root of the infected hair is covered with a sheath of spores *Microscopic examination of the infected hair* shows mosaic distribution of small spores 2 to 3 μ in diameter On microculture fusiform pointed macroconidia are seen at the end of fertile hyphae The microconidia are of the type of acladium along the side of the hyphae Three important microspora which cause infection of the hair are

(1) *M audouini* (2) *M canis* (3) *M gypseum*

PLATE XI

MICROSPORUM AUDOUINI



(a and a1) Inf ted ha r sl owing mosaic arrangem nt of small sp ires Adamson s fring at the bulb of the hair (c) Giant colony of *M aud u* i

MICROSPORUM AUDOUINI Gruby 1843

Synonyms *Trichophyton decalvans Sabouraudites audouini Closteriosporia audouini M umbonatum M velveticum M tardum M tomentosum M depauperatum M villosum*

They cause scaly ringworm of the scalp in children (not seen in Indians)

Direct examination The fungus forms a mosaic sheath around the stump of the hair (Pl XI a a_1) There is no tendency to chain formation along the long axis of the hair as in the case of trichophyta the spores are round or oval small and 3 to 5 μ in diameter Mycelia may be seen in infection of the glabrous skin

Cultural characters In Sabouraud s agar on the 3rd day after inoculation the *primary culture appears as a feathery fluff* and shows greyish white growth with scanty aerial mycelia With the growth of the colony radial furrows appear with a central elevation or an umbo characteristic of the growth and typically seen on Sabouraud s maltose agar (Pl XI c) Pleomorphism is not common

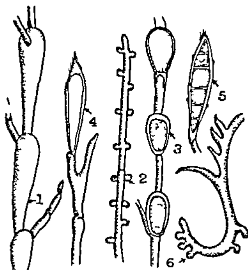


Fig 4—1 Myc l l a ju t M cro on d 3 Chlamy lo por s 4 Ma o on dium w thout sept 5 Septate mac ocon l um witl l 6 Hyi h e ı ct nate

Microculture Fusiform macroconidia are occasionally seen microconidia are of acladium type and not in groups as in trichophyta Mycelial racquets chlamydospores and hyphae pectinate are frequently observed in Sabouraud s media (Fig 24—1 to 6) and natural media like wheat or barley

Wood s light The infected hair stumps show fluorescence as bright clear green areas Usually all the hairs in a lesion are seen to be involved In a ten days old culture it appears dull clear and mouse grey throughout

Animal inoculation Animals are resi t nt to infection after inoculation with this fungus

MICROSPORUM CANIS Bodin 1902

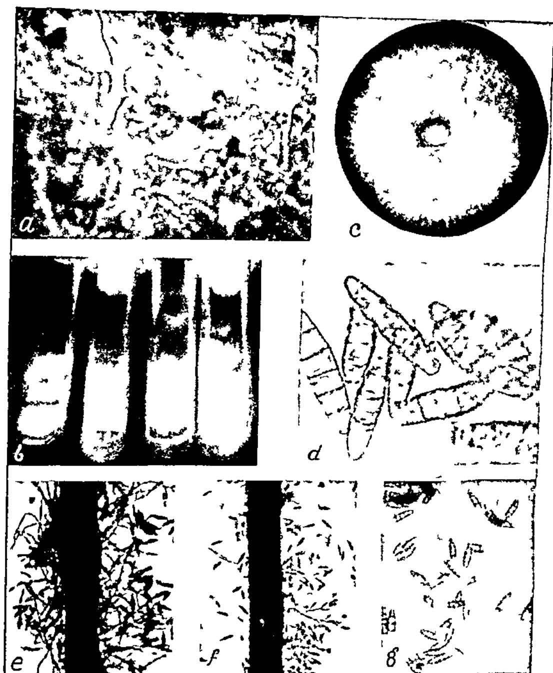
Synonyms *M lanosum M equinum M felineum M caninum M pseudo lanosum Sabouraudites lanosum Sabouraudites lanatus Closterosporia lanosa M stillianus M aurantiacum M simiae M obesum etc*

This often causes microsporosis with kerion formation It has been recorded from Europe and America but not from India

PLATE XIII

MICROSPORUM GYPSEUM

(From favus in a rabbit)



(a) Mycelia in the favus [illegible] high power ([illegible]). (b) Growth on Sabouraud maltose agar—primary culture and subcultures. (c) Giant colony on Sabouraud's maltose agar. (d) Macroconidia high power ([illegible]). (e) Hair [illegible] found naturally infected [illegible] the [illegible] showing macroconidia. (f) Fungus growing from the infected hair, low power [illegible]. (g) Macroconidia under low power [illegible].

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arrangement The infected hair shows a sheath of spores with rosaries When the infective stage is complete the microscopic appearance of the hair is indistinguishable from that of other microspora Lesions of the smooth skin show short chains of spores in the scale Favic scutula show mycelia and spores (Pl XIII a)

Cultural characters In Sabouraud s agar the colony grows fast with brownish white powdery aerial mycelia often giving the appearance of suede The cinnamon brown colour of the colony is characteristic A central umbo almost invariably appears about 2 weeks after subculture The margin of the colony is often fringed (Pl XIII c) Furrows are absent but there may be concentric rings in some cases

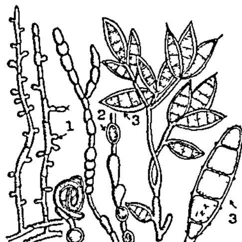


Fig 26—M gyp m 1 Microconidia Chlamydospores 3 Septate macroconidia tuberculated when old

Pleomorphism is characterised by growth of white sterile mycelia

Microculture Numerous macroconidia are produced They are fusiform in nature 8 to 12 by 15 to 50 μ They are pluriseptate and often ellipsoid with thin walls but tuberculated when old (Fig 26 and Pl XIII d e f g) Mycelial racquets chlamydospores and microconidia are often seen (Fig 26)

Wood s light The infected hairs fluoresce light green as in other microspora The growth is dull and clear cinnamon brown in colour throughout

Animal inoculation Young laboratory animals can be easily infected by *M gypseum*

Genus Trichophyton Malmsten 1945

General characters They attack the hair skin and nails The genus trichophyton is characterised by a large number of microconidia which are single celled thin walled hyaline round or clavate 2 by 4 μ borne en grappe or singly from the side of a hypha (thyrse) The macroconidia are less numerous cylindrical rather than fusiform In the faviform trichophyta microconidia are rudimentary and macroconidia are absent but intercalary and terminal chlamydospores are common

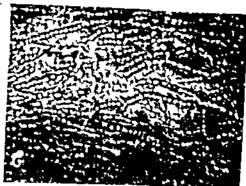
Macroscopically the cultures on Sabouraud s agar are often granular e g *T mentagrophytes* but they become downy when old In other cases they are faviform i e glabrous smooth and waxy Pigment varies from species to species e g white pink purple violet orange yellow or brown

CLASSIFICATION Different groups of this genus are formed based on the gross macrocopic appearance of cultures They are *T purpureum* *T crateriforme* *T mentagrophytes* *T rosaceum* and faviform trichophyta

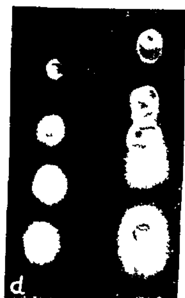
PLATE XV

TRICHOPHYTON TONSURANS

















Hair showing en[illegible] tr[illegible] [illegible] by *T. [illegible]* (a) 43 (b) 43 [illegible] 10 [illegible] (c [illegible] d) Primary [illegible] on S[illegible]bourau[illegible] malt[illegible] agar (e) Giant colony with [illegible] (f) Microculture from infected [illegible] (g and h) m[illegible] on [illegible]

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produced along the mycelium or en grappe Chlamydospores mycelial racquets and nodular organs are also present Spirals are characteristic

Wood's light In young culture the colour is bright and light blue throughout the colony but in the fluffy growth it is seen only along the periphery In older colonies a light blue border is characteristic

Animal inoculation It is occasionally successful

CRATERIFORM GROUP

TRICHOPHYTON TONSURANS Malmsten 1845

Synonyms *T crateriforme* Sabouraud 1902 *T effractum* Sabouraud 1910 *T fumatum* Sabouraud 1916 *T regulare* Sabouraud 1910 *T exsiccatum* Sabouraud 1910 *T polygonum* Sabouraud 1910 *T umbilicatum* Sabouraud 1910 etc

The organism causes endothrix trichophytosis or black-dot ringworm of the scalp and this is generally seen to infect children in France and other parts of Europe But seven cases were recorded by Dey and Maplestone (1941) in an epidemic in a European school in Calcutta The lesions on the scalp are small patches usually multiple without any inflammatory changes The hairs under the scales appear like letters S or Z or twisted spirally It might infect the glabrous skin as an extension from the scalp nails may be affected secondary to scalp infection In smooth skin the lesions are circinate non inflammatory with scale formation (Tinea circinata)

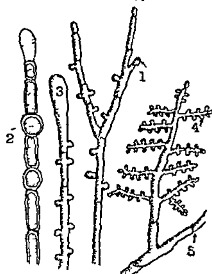


Fig 23 T tonsurans (1) M o n ha (2) Chlamydospores (3) Terminal club (4) Microconidia on compound branches

Direct examination In the hair spores are large seen in chains along the hair shaft (Pl XV a b) Mycelial filaments are 4 to 5 μ in diameter and old mycelia show spores with square-cut ends The spores are differentiated from those of other endothrix trichophyta e g *T acuminatum* or *T violaceum* which are oval in shape

Cultural characters The growth is slow and shows a white or cream coloured velvety surface with a central crater which develops with the age of the culture The centre becomes folded with irregular radiating furrows (Pl XV c d e) The colour in the central portion of the growth is gradually transformed into yellow with age Pleomorphism is rare

Microculture Macroconidia are rare and when present they are rudimentary club shaped and poorly formed Microconidia are numerous held either

laterally or en grappe often with a compound branching arrangement (Pl XV, g h) They are either sessile or borne on short sterigma Chlamydospores are abundant (Fig 28)

Wood s light With filtered ultraviolet rays the infected hair appears dull white in colour but in culture the growth shows a dark olive colour throughout

Animal inoculation Spontaneous healing is observed when guineapigs are inoculated with the fungus

TRICHOPHYTON SULPHUREUM Sabouraud 1910

This fungus is common in England and is very similar to *T tonsurans* In children it produces lesions of the scalp and glabrous skin

Direct examination Spores are large 4 to 5 μ in diameter and seen in chains inside the hair shaft Scraping from the lesion of the smooth skin shows mycelial filaments

Cultural characters The growth is fairly rapid The colony is velvety at first with a central nodule showing a delicate primrose colour *With the age* of the culture the growth becomes folded with a small crater in the centre and the colour soon changes to sulphur yellow On Subculture the growth is rather fluffy covered with a lighter yellow colour and the central pigment is often lost

Microculture Microcodidia are numerous and are seen laterally and en grappe Macroconodia if any are rudimentary or lacking Chlamydospores are often seen

Wood s light Infected hairs show a pale grey colour

Animal Inoculation Results are irregular

TRICHOPHYTON SABOURAUDI Blanchard 1896

Synonyms *T accuminatum* Bodin 1902 *T pilosum* Sabouraud 1910

It is responsible for endothrix trichophytosis in France and essentially resembles *T tonsurans in its cultural and morphological characters*

GYPSEUM GROUP

TRYCHOPHYTON MENTAGROPHYTES (Robin) Blanchard 1896

Synonyms *Microsporum mentagrophytes* Robin 1856 *Achorion quinkaenum* Blanchard 1896 *Trichophyton gypseum* Bodin 1902 *T equinum* Gedoelst 1902 *T granulosum* Sabouraud 1909 *T radiolatum* Sabouraud 1910 *T asteroides* Sabouraud 1910 *T lacticolor* Sabouraud 1910 *T niveum* Sabouraud 1910 *T radians* Sabouraud 1910 *T denticulatum* Sabouraud 1910 *T interdigitale* Priestly 1917 *T C Hodges* 1921 *T Kaufmann Wolf* Ota 1922 *T pedis* Ota 1922 etc

This group consists of at least three different types namely (1) *T gypseum* or granular type (2) *T interdigitale* or the white fluffy type and (3) *T niveum* or the compact powdery growth Immediately after isolation from

the hair or rarely from the skin the granular type of growth is very characteristic On repeated subcultures of the granular type or very often after isolation from the skin the fluffy growth is seen giving the appearance of *T interdigitale* and this is rarely rev rsible to the original type The gypseum type is the animal adapted strain and produces the maximum inflammatory reaction of the hair follicles *T interdigitale* on the other hand is a human adapted strain but it has also a tendency to mild inflammatory reaction in cases of tinea pedis particularly on the insteps of the foot In the latter condition the inflamma tory reaction is very characteristic *T niveum* is a degenerated form of *T interdigitale* and a culture of *T interdigitale* when old gives a similar growth character In all these types pigmentation in the depth of the medium is present and characteristically dark rose tan

Direct examination Hair shows the character of an ectothrix trichophytosis and the fungi are seen outside the hair The spores are small (Pl XVI a) like those of microspora In vesicles or macerated skin *T interdigitale* appears as short mycelia often with shreds with little branching (Fig 29)

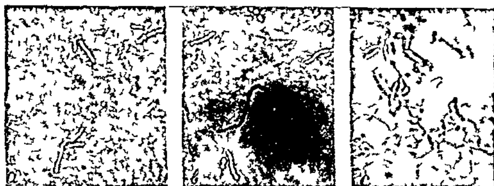


Fig 9—(a and b) T i t d it le with sl re ls of mycelia n the skin of I It t s (c) Mosai fungus n the bl ster skin without a y true mycel a th s is du to deposit f chol terol

Cultural characters In Sabouraud s agar the growth of *T gypseum* is characterised by coarsely powdery surface The growth is very rapid and the whole surface of the Frlenmeyer s flask is covered in 4 to 6 weeks by the growth In certain cases fluffy growth may appear in certain sectors of the growth during *this period The colour is usually dark rose tan In the gypseum* growth a few concentric rings may appear on the surface The margin of the growth is often fringed (Pl XVI b)

T interdigitale is characterised by a white fluffy growth from the beginning and after a variable period of subculture it passes to the *niveum type* when the growth is fully degenerated and pleomorphic In such a case the whole surface of the medium is covered by a snow white friable growth The growth which is powdery comes out in flakes when touched with a loop

Microculture *T gypseum* shows numerous macroconidia with either 3 or 4 septa Microconidia are almost always en grappe and also

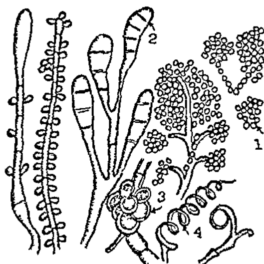


Fig 30 *Trichophyton gypseum* (1) Microconidia en grappe (2) Macroconidia with a few septa (3) Nodular organ (4) Spirals

borne laterally Microconidia are characteristically round in this case Spirals are typical Chlamydospores mycelial racquets pectinate hyphae and nodular organs are often seen (Fig 30)

In *T interdigitale*, round micro conidia are often seen in large clusters Macroconidia and spirals are usually seen immediately after isolation but they gradually disappear in subsequent subcultures Chlamydospores mycelial racquets nodular organs are usually present

In *T niveum* fragmented mycelia and microconidia are only seen

Wood s light In ectothrix trichophytosis of the scalp or beard areas fluorescence is absent the skin or nails also donot show any fluorescence The granular type of growth is typically bright and shows concentric bands of colour It is bluish violet in the centre and fawn colour at the periphery *T niveum* shows a uniform yellow tone

Animal inoculation The granular type of growth *(T gypseum)* can be inoculated successfully into guineapigs (Pl XVI f) cats rabbits but the fluffy type *(T interdigitale)* does not usually show this pathogenicity for these animals

ROSACEUM GROUP

TRICHOPHYTON ROSACEUM Sabouraud 1910

Synonyms *Epidermophyton gallinae* Megnin 1881 *T gallineae* (Megnin 1881) Blanchard 1896 *T roseum* Bodin 1902 *T megnini* Blanchard 1896 *T vinosum* Sabouraud 1910 *Achorion gallinae* Sabouraud 1910

This group differs slightly from the rubrum group and contains a single species with various synonyms In man it causes tinea barbae or tinea capitis without marked inflammation tinea corporis and ringworm of nails It causes favus in chicken

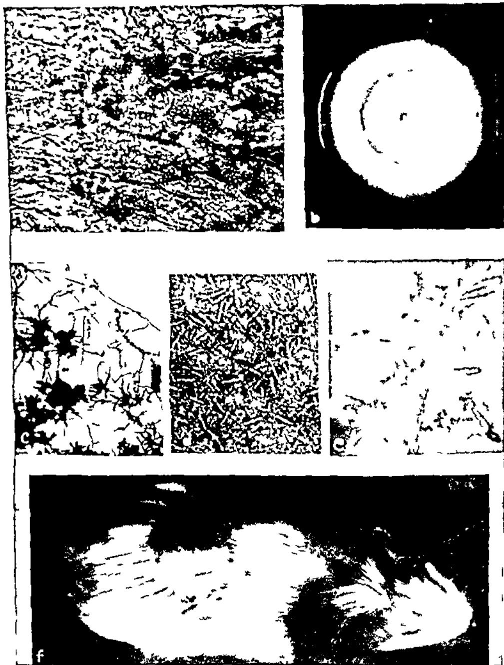
Direct examination In the hair they show ectothrix trichophytosis The spores are 4 μ or larger in diameter and are arranged in chains outside the hair

Culture On Sabouraud s medium the growth is characteristically cottony or velvety At first the colony is white but later it becomes pale rose or delicate pink and the reverse of the agar is currant violet or raspberry rose Some strains show cerebriform growth with surface cracks

Microculture The organism occasionally shows macroconidia Microconidia are often borne laterly and rarely en grappe Mycelial racquets and chlamydospores may be observed

PLATE XVI

TRICHOPHYTON MENTAGROPHYTES



(a) F tothr x trichophyton nf t g th l a l) Gi nt ol ny of T m t ph t (gyp um) ( ) R product ve end o gan nam ly ic ocon d m roconid a n l sp rals (d) Macroconidia (e) Macrocon d a an l spl e l mi o on d a (f) Su c sf l noculation into a guine pig

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PLATE XVII
ACHORION SCHOENLEINI



(a) Mycelia and spores in scutula (b) Chlamydospores in microculture (c) Culture—6 weeks old

PLATE XVIII
ACHORION ACTONI





(a) Scutula showing my[illegible]a and [illegible]pores (b) [illegible]nt colony ( ) [illegible] (d) [illegible] (f) Funnel-shaped [illegible] and [illegible]dospores

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Faviform Group

TRICHOPHYTON SCHOENLEINI (Lebert) Langeron and Milochevitch 1930

Synonym *Achorion schoenleini* Remak 1845 *Oidium schoenleini* Lebert 1845

Trichophyton schoenleini causes favu of the scalp smooth skin and nails in Europe It is characterised by formation of scutula on the scalp with deposit of mud plaster like crust When crusts are removed a raw surface is exposed On healing scars are formed resulting in alopecia in patches On the smooth skin vesicular or ringworm lesions form followed by accumulation of favic material consisting of scales and fungus mixed with secretion of a fatty nature When the nails are affected they are charactersed by hypertrophy with heaped up favic material

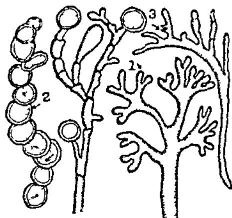


Fig 31—T *l pl yt* *hoe l* (*l*) Favi chandel ers ( ) Inte la y chlamydo po es (3) Hyp ha pe in te

Direct examination Favic scutula show mycelia with masses of branching hyphae and often chlamydospores Hair shows endothrix infection with spores or frag ments of mycelia in the hair which often contain air spaces attached to its margin

Culture Characteristic growth appears in about 3 weeks This shows a heaped up convex glabrous faviform cream coloured growth having a cerebreform or honeycomb appearance (Pl XVII) Pleomorphism is uncommon

Microculture Terminal and intercalary chlamydospores are common and numerous The growing end of the mycelium may show favic chandeliers (Fig 31) Aleuriospores are absent in Sabouraud s agar mycelial racquets are present Aleuriospores have been found by Langeron and Milochevitch in natural media This could not be confirmed by the author as it is difficult to grow the organism in these media

Wood s light Infected hairs show greenish fluorescence The culture gives a dull olive grey appearance throughout

Animal inoculation All the common laboratory animals may be infected

TRICHOPHYTON (ACHORION) ACTONI Dey and Maplestone 1936

Dey and Maplestone (1936) observed a favic trichophyton having a cultural and morphological character similar to those of *T schoenleini* but the terminal chlamydospores are very often funnel shaped instead of being oval or round (Pl XVIII) It is responsible for causing favus in Rajasthan and Kashmir in India

TRICHOPHYTON VIOLACEUM Bodin 1902

Synonyms *T album* Sabouraud 1909 *T glabrum* Sabouraud 1909 *Achorion violaceum* Bloch 1911

The organism is reponsible for causing *endothrix trichophytosis of the hair* characterised by black dot ringworm of the scalp but the infection may spread to the glabrous skin of the body nail or beard region

Direct examination (Plate XIX a b c d) The stump of the hair when examined under sodium sulphide solution shows mycelia containing spores in rows and often giving a beaded appearance The spores vary from 3 to 5 μ and are larger than those of microspora Mycelia are limited to the interior of *the hair and not outside it (endothrix)*

Cultural characters (Pl XIX Figs 1—4) The organism grows slowly like other faviform trichophyta The rate of growth is about *1 5 to 2 cm in 6 weeks* The growth is faviform and shows a glabrous surface with convolutions on the surface and radial groove marked near the periphery The primary culture gives a deep violet appearance but the violet pigment fades on repeated subculture till there may be a central pigmented portion but the surrounding portion becomes colourless and glabrous *(Pl XIX Fig 4) Pleomorphism is rare*

Microculture (Fig 32) The hanging drop culture does not show any typical microconodia formation Mycelia show septa with formation of numerous arthrospores and chlamydospores which may be intercalary or terminal like favic nails Mycelia show irregular branching and rackets are often seen but *aleuriospores* are either rudimentary or absent

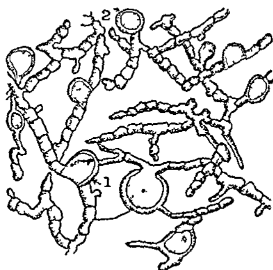


Fig 32 —*T Vi lac m* Arthrospores are plenty with (1) Intercalary and (2) Terminal chlamydospores

Wood s light Fluorescence is not seen as in the case of *T violaceum* infection

Animal inoculation Animal inoculation on the skin of guinea pigs and rabbits *were found to be* doubtful but the inoculation in monkey was successful 10 days after inoculation and in one of the two *monkeys* inoculated by the author the lesion was faviform in character (Pl XIX Fig e)

TRICHOPHYTON CONCENTRICUM Blanchard 1896

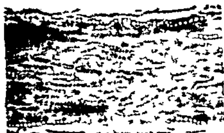
Synonyms *Endodermophyton concentricum* Castellani 1910 *Trichophyton Castellani (Perry)* Castellani 1908 *Trichophyton mansoni* Castellani 1905 *E indicum* Castellani 1911 *E tropicale* Castellani 1919 *E roquettei* Fonseca 1925

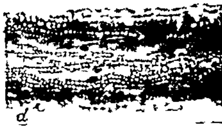
Direct examination Scales show septate intersecting mycelia (Pl XX a) easily stained with McGuire s stain or seen under a coverslip preparation with sodium sulphide

PLATE XIX
TRICHOPHYTON VIOLACEUM



















(a) I fectio of interio of the ha (c d) Be led appea ance of the fungus infecting the hair (e) I avie l s on n monkey
Isol tion in S bou aud s proof med um from (1) ha r ( ) pus n the ha r foll cl (3) Subcultu e (4) lo s of pigment by repeated subcultur in the s me med um

PLATE XX

TRICHOPHYTON CONCENTRICUM



(a) Scales of tinea imbricata showing mycelia (b) Primary culture from scale (c) Sub culture (d) Giant colony (e) Micro culture showing chlamydospores (f) Growth of the fungus in hanging drop preparation from a scale (High power 43)

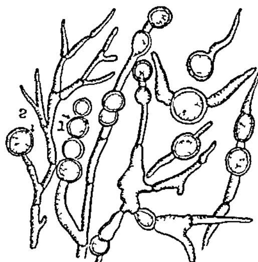


Fig 33—T nr r e m (1) Intercalary chlamydospores ( ) Terminal chlamydo po s

Cultural characters Primary culture in solid medium is difficult owing to the fact that the redundant portion of the horny layer of the epidermis does not give any growth Fresh material adhering to the skin should be utilised rejecting the redundant part sticking out

For culture treat the scales in alcohol for 5 minutes and inoculate tiny bits of infected material in glucose broth Sabouraud s glucose agar and Czapek s synthetic agar In glucose broth the growth appears on the 3rd or 4th day and forms as a powder puff ball of mycelia In Sabouraud s glucose agar visible growth occurs on the 4th or 5th day but in Czapeck s synthetic medium the growth is delayed till the 6th or 7th day Subculture in Sabouraud s medium maintains the cultural character for a long time without pleomorphism The growth is about 1 cm in 3 weeks The character of the growth is cerebriform greyish brown colour covered with white powder The growth increases to the size of 1 5 cm in 6 weeks On glucose agar the growth is raised yellowish brown in colour Under reduced oxygen tension in glucose agar the colour develops to a salmon pink when the tube is secaled with a rubber cap

Microculture Terminal and intercalary chlamodospores are characteristic Arthospores in chain form when the growth occurs in glucose broth Mycelial racquets are common and aleuriospores are absent or rudimentary (Fig 33)

Wood s light The culture shows a dull yellowish fluorescence

Animal inoculation Inoculations into human voluarteers has been successful

TRICHOPHYON FERRUGINEUM (Ota) Langeron & Milocheritch 1930

Synonyms *Microsporum ferrugineum* Ota 1921 *M japonicum* Dohi and Kambayashi 1921 *M aureum* Takeya 1925 *M orientale* Carol 1928

It causes ringworm of the hair in children in China The infection was recorded in a European school boarding in India (Dey and Maplestone 1939)

Direct examination Infected hair shows spores having an arrangement like those of microsporum they are about 3 μ in diameter

Culture The growth is slow convex raised glabrous and faviform with rusty colour and hence the name—ferrugineum Irregular radial furrows

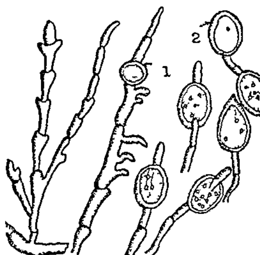


Fig 34—*T f ugine m* (1) Intercalary and (2) Terminal chlamydospores

divide the growth into sectors The growth may be covered with duvet in the margin (Pl XXI b)

Microculture The fungus is characterised by of terminal chlamydospores in long the are 20 to 30 μ which with their ends pointed Atypical mycelial racquets rudimentary hyphae pectinate are often present Aleuriospores are rare when present they are sessile and atypical

Wood s light The infected hairs do not show fluorescence

Animal inoculation Inoculations to laboratory animal are sometimes successful (Pl XXI d)

TRICHOPHYTON DISCOIDES

Synonym *Ectotrichophyton verrucosum* Bodin 1902 *Ectotrichophyton ochraceum* Sabouraud 1909 *Ectotrichophyton album* Sabouraud 1909 etc

It primarily affects the cattle It causes large spored ectothrix trichophytosis with formation of kerion in children and tinea barbae in adults One case of kerion caused by this fungus has been recorded in India by Dey & Kakoti (1955)

Direct examination Spores are seen in rows and are about 3 to 5 μ in diameter The mycelia often show a beaded appearance No mycelia are seen inside the hair (Pl XXII a)

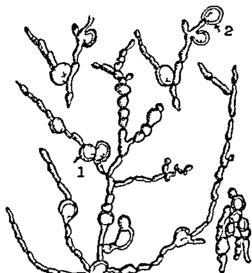


Fig 3 —*T i h phyt n d oid* with a t l r spores an l (1) Int r alary n l ( ) Terr nal l la nv l sp r s

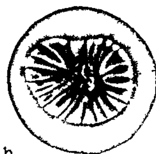
Cultural characters The growth is convex raised smooth and waxy and faviform with irregular folds in the centre with radiating grooves at the periphery It is characterised by the presence of a pigment when recently isolated (Pl XXII) But the pigment often disappears on sub culture and may be completely lost in subsequent subcultures Pleomorphism which is characterised by appearance of down on the surface of the glabrous growth is seen when subculture is delayed

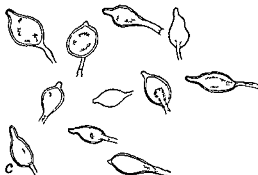
Microculture (Pl XXII) The mycelia show intercalary and terminal oval or round chlamodospores (Fig 35 Pl XXII d) Mycelial racquets are frequently present Microconidia are absent

PLATE XXI

TRICHOPHYTON FERRUGINEUM





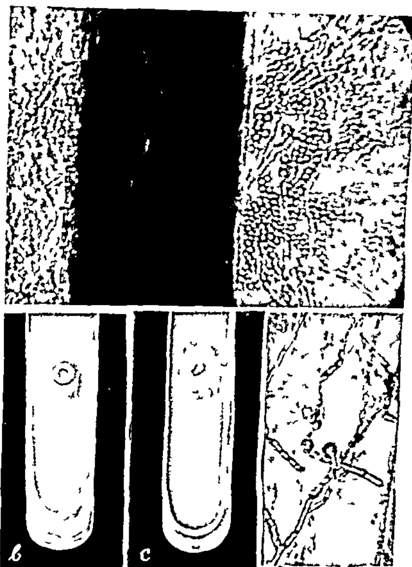




(a) Ha r show ng small pores w th mosaic appearan e (b) G ant c lony sl ow g fav form ch racter (c) Macrocon d a in m croculture (d) Hair of the exp imental a im l show ng tempo ry infect on

PLATE XXII

TRICHOPHYTON DISCOIDES



(a) Fctothrix trichophyto is of the hair (b) Prim ry ult re or Sabouraud's glu ose agar (6 we k old) ( ) Sul ulture b ming pleomorphic (d) Terminal chlamydo por in micro ultur

Wood's light The infected hair gives a dull white fluorescence and is difficult to detect In culture the growth appears to be dull white but clear

Animal inoculation Experimentally the fungus produces lesions in common laboratory animals

GENUS EPIDERMOPHYTON

EPIDERMOPHYTON FLOCCOSUM (Harz) Langeron & Milochevitch 1930

Synonyms *Acrothecium floccosum* Harz 1871 *Trichothecium floccosum* Harz 1870 *Epidermophyton inguinale* Sabouraud 1910 *E plicarum* Nicolau 1913 *E clypeiforme* MacCarthy 1925 *Trichophyton inguinale* Sabouraud 1907 *T intertriginis* Sabouraud 1905 *T cruris* Castellani 1908 *E cruris* Castellani and Chalmers 1910

It invades the skin producing a condition of eczema marginatum of Herbra or ringworm of the groin commonly known as dhobie itch But it may affect the glabrous skin of other parts of the body as well as the nail It does not affect the hair

Direct examination Mycelia containing chains of spores are seen in a fairly large number They are usually wavy in appearance (Pl XXIII a)

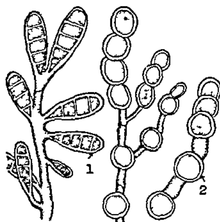


Fig 36—*Epidermophyton floccosum* (1) Pluriseptate macroconidia with rounded ends (2) Chlamydospores

Cultural characters It is a slow growing fungus In Sabouraud's glucose medium the colour is lemon yellow or olive green with short white cottony duvet on the surface which are sterile The centre of the giant colony is folded with radiating furrows (Pl XXIII b) Pleomorphism is characterised by formation of white duvet on the surface of the growth

Microculture (Fig 36) Macrocodidia are large clavate smooth thin walled and pluriseptate with 3 to 4 cells and 7 to 12 μ by 20 to 40 μ in size They are often seen in clusters with rounded ends Chlamydospores are seen in large numbers Mycelial racquets are also seen Spirals if present are rudimentary in nature Microconidia or pectinate hyphae are absent

Wood's light The colony appears dark olive in colour

Animal inoculation Laboratory animals are not susceptible

TABLE VIII

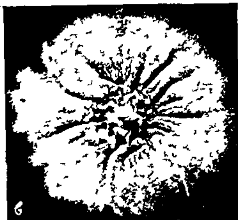
DIAGNOSTIC FEATURES OF MICROSPORUM, TRICHOPHYTON AND EPIDERMOPHYTON SPECIES

Description	Microsporum	Trichophyton	Epidermophyton
Colony morphology	Cottony or powdery aerial mycelia varying from white to buff colour	Cottony, granular or glabrous (smooth and waxy); pigment may be present; loss of pigment on subcultures	Powdery or velvety with radiating furrows on the surface and lemon yellow in colour
Microscopical			
Vegetative forms	Racquet mycelia, hyphae pectinate, chlamydospores well formed, spirals rare in species like *M. canis*	Racquet mycelia, chlamydospores, spiral hyphae, nodular organs, rarely hyphae pectinate. In faviform types—favic chandeliers and pectinate bodies in addition to racquets and chlamydospores	Racquets occasionally and chlamydospores frequently present
Microconidia	Small clavate 3 by 5 µ borne along the hyphae sessile or fixed on facets	Numerous small clavate subspherical or spherical 1–4 by 4 µ borne along the hyphae (thyrse) or in clusters (en grappe); they are rudimentary or absent in faviform group	Absent
Macroconidia	Large spindle shaped, thin walled when young but thick walled and tuberculated when old; size 8 to 15 µ by 40 to 50 µ in length; plurisептate but often without septa in *M.* [illegible] and [illegible]. They are pointed and contain fine hairs at the tip	These are club shaped or cylindrical organs 4 to 6 µ by 10 to 50 µ, smooth, thin walled, hyaline, containing 3 or 4 septa. In faviform groups macroconidia are absent	Large, clavate, septate, smooth, thin wall, with rounded ends and often in clusters

PLATE XXIII

EPIDERMOPHYTON FLOCCOSUM

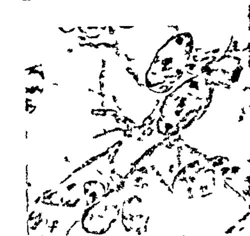












(a) I fec e1 1 (b) G owth on Sabou a d e maltos ag r (c) Mac oconid a und r low pow r (d) Chl mydospores (h gh power 43×8) M crocon d a under high power (e) 43×5 (f) 43×1

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M audouini infection of the scalp and clinically it can be easily differentiated from black dot ringworm caused by trichophyton infection (Table IX) From the hairy scalp the infection *may spread on the face neck* or *trunk* and called tinea circinata These are small patches on the glabrous skin and produce small scaly irritable patches without the usual festooned margin (Pl XXIV)

Kerion formation is *commonly seen in infections* caused by *M canis* and *M gypseum* which are animal microspora

Diagnosis *Clinical picture* Microsporum infection is essentially a disease of children especially during the school going age. The presence *of* one or more bald scaly areas exhibiting broken hair stumps sticking out in different directions is absolutely diagnostic

Wood s light For further varification examination of the patient in a dark room under Wood s light shows fluorescence of the affected hair attacked by *M audouini* In order to obtain satisfactory results the affected part should be cleansed with *ether alcohol mixture* *Wood s light is filtered ultraviolet rays* through Wood s filter The glass is made of sodium barium silicate containing *about nine per cent of nickel oxide* *The filter permits the passage of the the* spectrum of monochromatic ultraviolet rays in the region of 3650A° which produces the maximum fluorescence in case of *M audouini* infection

Duckworth s chloroform test A few suspected hairs are placed on a glass slide and soaked with a few drops of chloroform The test is positive when after the evaporation of chloroform the hair becomes chalky white in colour A positive result is characteristic of microsporum infection in which there is a sheath of spores around the infected hair

Microscopic examination The broken infected stumps of hair are mounted in a drop *of sodium sulphide solution under a coverslip and the solution is* heated without boiling After a few minutes the hair is examined under the *low power and then under the high power which shows a characteristic mosaic* appearance due to arrangement of spores in groups The spores are about 2 to 3 μ in diameter Near the root of the hair Adamson s *fringe may be seen* (Pl XI b) *indicating that infection is spreading in this part of the hair*

For the diagnosis of species study of cultural characters is *necessary*

TRICHOPHYTOSIS OF THE SCALP

Trichophyton infection of the scalp is chiefly due to endothrix trichophyta They cause *black dot ringworm of the scalp in children*

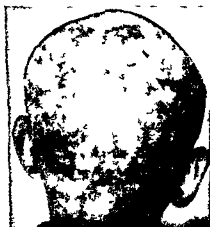
Classification Trichophyta have been divided into three clinical groups according to whether *the fungus infects the interior or* the exterior part of the hair or both the interior and the exterior When the infection is limited to the interior of the hair the fungus is called *endothrix trichophyton* *The spores of* the endothrix trichophyta are larger than those of microspora and are about 3 to 5 μ in diameter e g *T violaceum T tonsurans T accuminatum* Those which infect the surface or the external part of the hair or the hair follicle are called *ectothrix trichophyta* e g *T mentagrophytes* The fungi that *infect both* the interior and the exterior of the hair are called *ectoendothrix* or *neoendothrix*

PLATE XXV

BLACK DOT RINGWORM *(TRICHOPHYTON TONSURANS)*











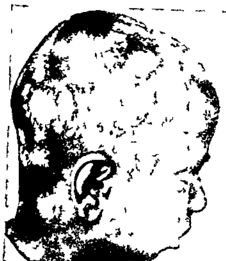


Black dot ringworm of the scalp caused by *T* [illegible] Note the small multiple areas of baldn[illegible] caused by stumps of brok[illegible]n [illegible]

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PLATE XXVI

BLACK DOT RINGWORM (*TRICHOPHYTON VIOLACEUM*)





Multiple patches of black dot ringworm of the scalp caused by *T. violaceum*

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But *this is no longer considered* as a separate clinical type because during the early part of infection an endothrix trichophyton may look like a neoendothrix

Ectothrix trichophyta have been further subdivided into those with small spores 3 to 5 μ in diameter i e *microides* e g *T mentagrophytes* Those with large spores are called *megaspores* The spores in this case are 5 to 7 μ in diameter e g *T rosaceum* *T discoides* Ectothrix trichophyta are often of animal origin and show inflammatory reactions with kerion formation

Etiology Three species of endothrix trichophyta may produce black dot ringworm of which one produced by *T violaceum* is the commonest in India (40 91 per cent of ringworm of the scalp) and is specially seen in Mohammedan children *T crateriforme* common in France has been isolated from Anglo Indian and European children in India *T sulphureum* is an allied organism common in England This and *T accuminatum* have not yet been encountered in India

Symptoms Black dot ringworm is characterised by small, multiple bald patches on the scalp which on close observation are seen to be studded with numerous black *dots at the mouth of each hair follicle This is due to* the hair being broken off at the point of emergence from the hair follicle giving a characteristic appearance (Pl XXV XXVI) In a certain number of cases the skin may be affected specially on the face neck where multiple ringed patches of tinea circinata are seen

Diagnosis Microscopic examination of the infected hair shows mycelial spores either oval or with square cut ends arranged in chains in the long axis of the hair These spores are about 3 to 5 μ in diameter and are larger than those of microspora It is very important to differentiate scaly and black dot ringworms which are tabulated

TABLE IV

DIFFERENCE BETWEEN MICROSPORUM AND TRICHOPHYTON RINGWORM

	Microsporum (scaly) ringworm	Trichophyton (black dot) ringworm
Patches on the scalp	Only o e or two big scaly patches	Multiple small bl ck dot patches
Hair stump	Stump are long and stick out in d fferent d r ct ons Grey h sheath forms at the root of the ha	Stumps are ve y small and flush with th surface of the skin. No sheath i s en They break eas ly at the time of pilation
Microsco scopy	Spo es are small (3 μ) and give a mosa c appea ance	Sp res are large (5 μ) ar d give a beaded appearance along the long ax of the hair
Culture	Shows characteristic growth of the species	Shows cha acteristic growth of the speci

Kerion It is a suppurative condition of the scalp in cases of ringworm with inflammatory changes of the hair follicles The primary infection is responsible

for the suppurative condition but secondary *infection is often present* The inflammatory reaction is often beneficial to the host as the process is nature s attempt to get rid of the infection by suppuration and spontaneous *epitation*

The infecting fungus may be *M canis M gypseum* or *T mentagrophytes* (Pl XXVII) The condition of kerion is characterised by a boggy, *inflammatory* swelling of the ringworm patch of the scalp produced by a fungus of animal origin Individual hair follicle shows folliculitis to begin with and this later progresses to an acutely inflamed patch with pus formation Hairs in the patch become loose and can be easily pulled out with a pair of epilation forceps As suppuration occurs there is a tendency of spontaneous cure by scarring and permanant baldness results due to obliteration of the hair follicles by the scar *tissue*

Prophylaxis Ringworm of the scalp is a highly contagious disease and is extremely common *amongst school children Epidemics may break out in* boarding schools All children should have careful examination of the scalp before admission into the school and also periodically when they join the school after vacations Help of Wood s light is essential for this As soon as any infection is detected, the child should be isolated and put under treatment Hats hair brushes combs etc of patients and all contacts should be sterilised but when this is not possible these articles used by the patient should be burnt The patient should wear a tight fitting linen cap through out the course of treatment He or she should not attend the school till completely cured In a boarding school *the child should be segregated*

Treatment The main principle of treatment is to get rid of the infected hairs by a process of epilation Epilation is followed by application of mild antiseptic ointment which contains non irritant fungicidal agents The layer of ointment acts on the spores of the fungus and also prevent the spread of infection by hair The ointment should not be strong enough to cause too much irritation or inflammation of the affected part Ointments that are usually used are 5 per cent ammoniated mercury or 1 per cent thymol or 0 1 per cent phenyl mercuric nitrate or an ointment containing 0 5 per cent each of iodine crystal and cinnamon oil Irritant applications like croton oil turpentine or chrysarobin are unnecessarily hazardous Loose hairs may be best removed by shampoos or a liquid soap Rubbing too vigorously or too frequently may break the hair instead of making them loose In infections with fungi of animal origin like *T mentagrophytes M lanosum* inflammatory reaction is severe and as a result there is a tendency of suppuration and spontaneous cure by scarring of the hair follicle In these cases prognosis is good and all that is required is the application of *a mildly antiseptic ointment*

ANTISEPTIC COMBINED WITH HORMONE THERAPY In a study by Lewis Hopper and Reiss the authors found oestrogen and androgen to be quite effective *in vitro* against ringworm fungi but clinical results were poor when such agents were applied locally to areas of infection Gonadotropic hormones were tried by Ghosh and Dey (1945) in 23 cases of ringworm of the scalp combined

with local application of fungicidal paints containing thymol and cinnamon oil in tincture iodi mitis or 0 1 per cent ointment of Phenyl mercuric nitrate The use of the gonadotropic hormone has been limited apprehending that precocious puberty might be initiated specially in girls Oestrogenic hormone like stilboestrol is given in doses of 1 mg three times daily for 20 days or until the child exhibits symptoms of toxicity such as inflammation of the breast vomiting etc It has been found that combined treatment is better than either hormone or antiseptic ointment alone Those who are interested are referred to the original paper

EPILATION This may be rendered in one of the following ways The hair should be cut short and the scalp should be examined with Wood s filter from time to time for the progress of the case

MANUAL EPILATION This is feasible when the patch is small and single The infected hairs as revealed under Wood s light in a dark room are pulled out with a pair of epilation forceps The process is repeated twice weekly and the patches are covered with the antiseptic ointment after epilation On other days the patient can apply soap or shampoo after which the ointment is applied The patient should wear a tight linen cap which should be boiled every day

EPILATON BY IRRITANT DRUGS Local application of irritant drugs produces acute inflammation and loosening of the hairs which are then easily pulled out e g croton oil 2 per cent chryserobin in acetone But in such applications there is danger of scarring and permanant baldness Suppuration must however be stopped before the application of X ray treatment

EPILATION BY THALLIUM ACETATE Thallium acetate administered orally in therapeutic doses loosens hair roots so that all the hairs can be easily pulled out after 18 to 21 days The drug has the disadvantage that the therapeutic and toxic doses are close to each other so that there is always a risk of using it The therapeutic dose is 8 mg per Kilo body weight given as a single dose in children upto 10 years The toxic dose is 8 5 mg per Kilo body weight

Mode of administration The child must be acurately weighed in a nude state and the weight is recorded The dose is calculated according to the body weight and thallium acetate is administered as a single dose in a cupful of sweetened water Hair begins to fall after 3 weeks The therapeutic action of the drug is due to the selective action throgh the sympathetic trophic nerves Common toxic symptoms are pain in the muscles and joints convulsions of choreic nature albuminuria gastrointestinal disturbances etc Adhesive plaster is applied all over the scalp on the 18th day after the draught and complete epilation is produced by taking off the plaster cap on a subsequent date Fungicidal remedies should then be applied to eradicate the infection thoroughly and completely before regrowth of the hair which commences after four weeks

EPILATION BY X RAYS Total epilation with X rays followed by the application of antiseptics is the standard method of treatment For X ray epilation the method of Adamson Kienbock is followed In this the scalp is divided into five areas namely frontal vertical occipital and one over each ear and

approximately a dose of 370 units of X rays are administered to each area This treatment does not kill the fungus but the hair papillae are devitalised temporarily and within 21 days hairs fall out including the infected ones containing spores and the fungus The scalp still remains infected and antiseptic ointment as mentioned before should be applied daily for this purpose along with the application of soap and wash

The cure in such cases should be carefully observed and examined under Wood s light so that no area remains untreated or becomes newly infected

Contraindications of X rays Impetigenous pustular lesions should be treated and cured before the X ray exposure otherwise the lesion may spread on the whole scalp Kerion cases should not be treated with X ray

Danger of X rays A permanat baldness may occur after an over exposure This should always be done by experts with an indemnity bond from the guardian of the patient Ulcers may be aggravated and may cause deep scars with permanant baldness

Treatment of Kerion Thick crusts are removed with starch and boric poultice daily for several days till the scalp is clean Loose hairs are removed with a pair of epilation forceps When the part is fairly clean lotio triple dye is painted twice a day on the patch

TINEA BARBAE

Synonyms —Tinea sycosis hyphogenic sycosis etc

Definition This is an infection of the beard areas of the face and neck caused by ectothrix trichophyta or microspora of animal origin producing inflammatory lesions and pustule formation Cases have been reported from Europe and America two cases have been recorded in India by Dey et al (1946) caused by *T gypseum*(Pl XXVII d)

Pathogenesis The disease may be transmitted from man to man through direct contact or shaving in barber s shop The infection may be contracted also from infected animals like horses

Signs and symptoms The disease starts on a localised area of the beard region as red itchy acutely inflamed scaly patch with formation of pustules at the root of the hair giving a boggy appearance Suppuration takes place in the hair follicles which remain widely gaping The hair remains loose in the follicle and the infected hair can be easily pulled out with a pair of epilation forceps The affected patch becomes raised inflamed and painful In milder cases the inflammatory reaction may be less severe or only small areas of scaly patches are seen In an advanced case almost the whole of the beard area may be involved in patches with groups of suppurating hair follicles The upper lip is not usually involved but the infection may spread here also involving the moustache area

Differential diagnosis Tinea barbae should be differentiated from sycosis barb e the latter being staphylococcal in origin Sycosis barbae produce superficial pustular folliculitis There is pus in each follicle with erythema

PLATE XXVII

LESIONS CAUSED BY

TRICHOPHYTON MENTAGROPHYTES









( ) (b) i ( ) ke on ot tl calp (d) Γn ı b rl ıe

PLATE XXVIII
RINGWORM OF THE GLABROUS SKIN













(a) (b) (e) and (f) caused by *T. purp[illegible]m*. (c) Extension from ringworm of the [illegible] caused by *T. [illegible]olaceum*. (d) Eczema marginatum of Hebra caused by *Ep[illegible]d[illegible]rm[illegible]ph[illegible]flo[illegible]m*.

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and induration around the hair follicle The whole of the beard area is affected instead of patches as in tinea barbae Hairs are not loose and cannot be easily pulled out

TABLE X

DIFFERENCE BETWEEN TINEA BARBAE AND SYCOSIS BARBAE

Tinea barbae	Sycosis barbae
DISTRIBUTION The infection is localised in patches single or multiple	The infection is generalised infecting all the hair follicles
ORGANISMS Trichophyta or microspora of animal origin	Staphylococci
LESION Kerion like boggy patches of inflamed areas Hair follicles are gaping and hairs are loose and pulled out easily	Hair follicles are affected with superficial pus formation and erythema and induration Hairs can not be pulled out easily
MICROSCOPIC EXAMINATION The fungus can be demonstrated in the hair	Hairs do not show any fungus

Treatment In a very early case when the infection is limited to the skin and has not affected the hair follicles local application of Whitfield s ointment or application of tincture iodi mitis is quite effective to remove the infection When the hair follicles are affected a preliminary application of hot boric compress or starch boric poultice will help removal of the crust Manual epilation is easy as the hairs are loose in the widely gaping hair follicles When the part is clean triple dye or tincture iodi mitis may be applied twice daily Phenyl mercuric nitrate ointment (0 1 per cent) or 5 per cent ammoniated mercury may be applied at night Sodium propionate (10 per cent solution in alcohol) may be substituted for ammoniated of mercury ointment In persistent cases X ray epilation of the affected parts is advised At least two microscopic examinations should be negative before the patient is declared to be cured

RINGWORM OF THE GLABROUS SKIN

This is an infection caused by a group of fungi and characterised by ringed vesicular lesions of the skin specially on the inguinal region loin back hands and feet or soddening of webs of toes exfoliative and hypertrophic lesions of the palms of the hands or soles of the feet They produce severe itching followed by weeping crust formation and exfoliation The lesions spread by peripheral extension to a large extent

Etiology The causative organisms are *Epidermophyton floccosum Trichophyton rubrum T interdigitale* and other trichophyta and rarely microspora

AGE The disease is commonly seen in adolescent and young adults and *may persist throughout the whole life* It is very rare in children below 12 years and this is accounted for by some due to the presence of thymus secretion *which inhibits the growth of the fungus in the glabrous skin*

SEX The infection is commoner in males than in females

FRICTION Friction of dhoti in the loin area chafing in the intergluteal fold and inguinal region remove the protective horny layer of the skin and *predispose to infection Constant washing with alkali soap* has the same effect by removing the superficial horny layer

TEMPERATURE The fungus grows well in hot and humid weather and the disease remains quiescent during the winter months

MOISTURE *Moisture is necessary for the growth of the fungus* and perspiration in the hot weather keeps up the moisture In the inguinal axillary and interdigital areas the skin becomes *sodden with perspiration as there is lack* of proper evaporation in these areas Sweat washes the acid mantle of the skin which cotains propionic and other aromatic acids and protect the skin from infection Thus an ideal substrate is provided for the germination of spores of the fungus and high atmospheric humidity augments the condition

SAPROPHYTIC LIFE OF THE FUNGI The fungus passes a saprophytic life outside the human body in moist earth wood damp leather and other organic substrates like decaying organic and vegetable matters Hence people walking bare footed or athletes are prone to this infection and in them growth of the fungus is favoured by *moisture in the interdigital regions* The fungus may thrive on seats of comode bath mats coir mats etc

Pathology In culture it can be demonstrated that the fungus has roots surface runners and aerial hyphae bearing spores The roots of the fungus grow downwards passing in between the prickle cells as far down as the papillae to open up the lymph spaces and derive their nutrition *This results in* formation of vesicles at the spreading margin of the lesion This is associated with intense itching due to irritation of the nerve endings until the tension is relieved by the rupture of the vesicle accompanied by serous exudation The serous exudate dries to form a thick scab containing the vegetative fungi and arthrospores at the spreading margin of the lesion Serum usually inhibits the growth of ordinary bacteria but streptococci *may grow* in the clear secretion causing secondary streptococcal dermatitis (For details see Acton and McGuire 1927)

Ringworm of the glabrous skin may be described under (1) Tinea circinata (2) Tinea corporis (3) Tinea cruris (4) Tinea axillaris (5) Tinea pedis etc

Tinea Circinata These are characterised by round or oval patches usually secondary to lesions on other parts of the body The lesion may spread from the scalp and is caused by amimal Microspora or Trichophyta *Microsporum audouini* infection of the glabrous skin is usually seen in children characterised by round or oval scaly patches without any typical ring formation The lesions are often seen on the neck forehead face or shoulder (*Pl XXVIII*)

Trichophyton infection of the glabrous skin may be caused by an endothrix or ectothrix trichophyton The lesion produced by *T violaceum* in children are often generalised multiple and scaly in character (Pl XXVIII) They may occur on the glabrous skin of the adult without any scalp lesion The lesions are scaly in character Lesions produced by ectothrix trichophyta show definite circinate patches the margin of which is raised and well circumscribed The spreading margin is often associated with vesicle and pustule formation

Tinea corporis Ringworm of the glabrous skin often occurs on the trunk and extremities as a spread from the primary affection of the crural region (See tinea cruris) In infections caused by *T rubrum* in India lesions spread extensively on the body with a typical purplish colour of the lesion

Tinea cruris The classical form of the disease is seen in infection caused by *E floccosum* The infection was originally described by Hebra in 1860 as eczema marginatum It is usually initiated by friction caused by underwears and this is why it is often called Dhobi itch The crural region may show ringworm caused by *T gypseum* var *interdigitale* and *T rubrum* The latter infection is common in India and very persistent *T gypseum* var *interdigitale* usually spreads from a nidus present in the web between the toes where it produces athlete s foot but in case of *T rubrum* infection of the foot nail or the inguinal region forms the nidus from where infection spreads on to other parts of the body

In the genitocrural region the lesion starts as a well circumscribed ringed lesion with a raised margin studded with small vesicles at the periphery The patch is severely itchy and the erythematous vesicles are soon broken and dry scabs form at the margin Streptococcal infection is apt to occur at this stage giving an acute eczematous condition of the lesion In an established case the lesions are symmetrically distributed showing a festooned raised gyrate margin It spreads peripherally on the inner margin of the thigh scrotum perineal and intergluteal regions and rarely to the skin over the penis Secondary infection by streptococci and staphylococci produce impetiginous scabs Hair involvement is unknown

Tinea axillaris These lesions which are clinically similar to tinea cruris are seen in the armpit and both the conditions namely tinea cruris and tinea axillaris are often seen in the same patient at a time

Tinea pedis The common causative organisms are *T rubrum* *T gypseum* var *interdigitale* and *E floccosum* Three clinical types are generally seen namely (1) Interdigital type (2) Vesicular type (3) Hypertrophic type in the sole of the foot

Interdigital type This is the commonest and the most important type and commonly known as athlete s foot mangoe toe or Hongkong foot etc The lesion is characterised by sodden whitish appearance of the skin between the fourth and fifth toes and forms the nidus of infection The infection is persistent and is maintained at this site for a long time with acute exacerbation in the summer and rainy seasons (Pl XXIX b)

Vesicular type This often originates from the margin of the foot and appears on the instep or back of the foot where the skin is comparatively thin At these sites they form vesicles in groups and a definite margin may be present in some cases The lesion shows an acute inflammatory reaction which is painful and it is often followed by pus formation The fungus that is isolated from this type of lesion is *T gypseum* or *T interdigitale* (Pl XXIX c)

Hypertrophic type This is seen in chronic cases of ringworm caused by *T rubrum* In this type the horny layer of the sole including the heel and side of the foot are thickened diffusely or in hypertrophic patches forming plaques The surface of the hypertrophic area shows exfoliation cracks and fissures (Pl XXIX a and e) They should be differentiated from similar hypertrophic lesion produced by *Nocardia keratolytica* (Pl IV Fig 2) yaws and syphilis Such a lesion is apt to occur sometimes on the dorsum of the foot also (Pl XXIX d)

Complications Secondary infection often takes place producing weeping eczema caused by streptococcal infection or a condition of cellulitis Phytides are occassionally seen on the palms and soles as a result of sensitisation caused by spores escaping into the blood stream from the site of primary lesion but fungi are absent in the id lesions

Melanoleucoderma and ringworm fungi There is a condition of melanoleucoderma as a late syphilitic condition characterised by hyperpigmentation of palms and soles giving an appearance like that of Pinta Infection with *T rubrum* is often associated with it and the fungus can be isolated in those cases It is not only present in the tropics but one such case was seen by the author in St John s Skin Hospital London (1950) The fungus in that case was found to be *T sulphureum* instead of *T rubrum* (Pl XXX)

Diagnosis Ringed lesions in the groin axilla or other parts of the body with scaly appearance and associated with intense itching are very much suggestive of ringworm but ringworm like lesions in the neck of adult persons is almost always due to seborrhoeic condition rather than ringworm

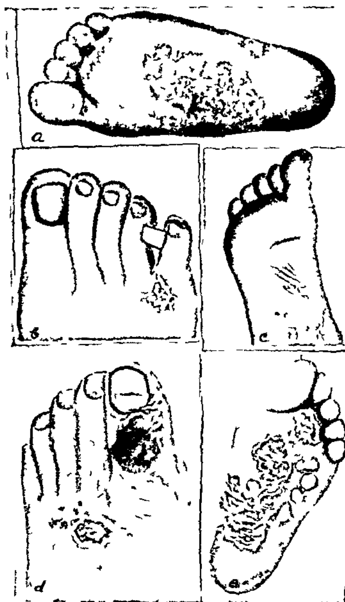
In interdigital affections the skin is sodden but on the instep vesicular lesions are characteristic This condition must be differentiated from pompholyx of the hands and feet caused by sensitisation Diagnosis should always be confirmed by the presence of fungi by microscopic and cultural examination of the material In pompholyx and other id reactions the fungus is absent and fungus infection is ruled out if the trichophytin test is negative

MICROSCOPIC EXAMINATION The part for scraping is first cleaned with a mixture of equal parts of ether and alcohol and then scraped with a sterile (flamed) Paget s knife The scraping material is collected between a pair of sterile slides A part of the scraping material is transferred on to another slide and a coverslip preparation is made with sodium sulphide solution The slide is gently heated without boiling and the preparation is ready for examination when there is complete keratolysis

While examining the scales care must be taken not to be confused with fungus like structures the so called mosaic fungus This is an artifact due

PLATE XXIX

TINEA PEDIS



(a and e)—Hypertroph patches (b)—Int d gital l ion (c)—\e cular l r
(d) Hypert ophic le ion w th ul er tion

PLATE XXX

MELANOLEUCODERMA









M lanole o lerma of tl e han l Note hyperkerato is of tl kin T b m wa i lated f om all of th m

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to deposit of cholesterol between the cells of the epidermis These deposits form structures like true mycelia but unlike mycelia they are irregular in their size and contour They are always found in the intercellular space and do not traverse across the cells whereas true mycelia always lie across the epithelial cells (Fig 29 c p 83)

CULTURE Infected materials can be cultured on Sabouraud s medium in test tubes but for the study of colony characters giant colonies are obtained in flasks containing Sabouraud s proof medium with maltose agar

Prophylaxis The disease is apt to recur and for this reason prophylaxis should be strictly observed The nidus in the interdigital or crural regions should be treated properly and radically cured Walking bare footed is strictly avoided As there is chance of contamination underwears should be boiled every day or as frequently as possible Public baths and comodes are sources of contaminations and these should be avoided as far as possible In the rainy season shoes may become mouldy The shoes should be disinfected with formalin spray at regular intervals and put in the sun Socks should be changed and boiled or disinfected every day Feet should be kept dry using sulphur and camphor powder other flexural and intertriginous regions of the body should be similarly treated Vinegar or 3 per cent acetic acid or powder containing propionic acid or undecylenic acid may be applied in the foot and intertriginous regions

Treatment Ringworm Is a chronic disease but in the genitocrural and other regions where the skin is thin acute exacerbation due to streptococcal infection is often seen In the acute condition evaporating lotions Goulard s lotion lotio calamine or 1 4000 solution of potassium permanganate may be applied locally But when the infection has further advanced lotio acriflavine (1 5000 aqueous) may be applied on a gauze soaked with the lotion intermittently for two to three hours three or four times a day This is applied in such a way that the part is not sodden When the oozing has stopped ungueutum zinc or borovaseline should be applied Secondary infections in the interdigital part of the toes with cellulitis is best treated with application of Pot permanganate lotion followed by application of lotio triple dye When dry this may be followed by application of Castellani s paint

In the chronic condition unguentum Whitfield is the best application particularly on the thin sensitive skin like those of scrotum groin or face In the groin as a routine measure undecylenate powder (10 per cent zinc undecylenate) or sulphur and camphor powder should be applied in the day time twice or thrice daily and at night application of Whitfield s ointment is advocated as a routine Dithranol ointment cures tinea more quickly than other remedies but there is a great danger of irritation from the drug For sensitive areas it should be used in a concentration of 0 5 per cent but in other chronic or resistant cases it may be used in a concentration of 1 to 2 per cent On the body hands feet and hypertrophic patches on the sole of the foot ringworm paint is an excellent remedy One application a day is quite effective

unguentum Whitfield may be applied in those areas at night In areas of secondary infection causing *pyodermia* *unguentum hydrarg ammon dil* may be applied to get rid of the secondary infection before Whitfield s ointment is *applied on the part*

TINEA UNGUINUM (Ringworm of the nail)

Ringworm of the nail is caused by a group of fungi and the infection is often *secondary to ringworm of other parts of the body* The infection is seen to involve nails of both fingers and toes as a result of extension of lesion from the neighbouring areas but the finger nails may be contaminated by scratching the body

Pathogenesis The disease is *very* common in India *It* is caused by *Trichophyta* and *E floccosum* The commonest trichophyta in India are *Trichophyton rubrum* but *T interdigitale* or *T violaceum* are rarely seen

Signs and symptoms The disease commonly starts on the free border or *the lateral margin of the nail plate The infection may be due to direct* extension of the lesion from the surrounding parts or as a result of scratching a ringworm patch on the body The spores are usually lodged under the nail plate and mycelia proliferate from these spores causing a greyish white mass consisting of keratin and mycelial filaments which raise the nail from its bed The infected nail becomes hypertrophic opaque lustureless and brittle *yellowish* white in colour The nail bed is gradually involved and the *nail* shows a *typical moth eaten appearance* (Pl XXXI)

Diagnosis Psoriasis may involve the nail plate very often resembling ringworm of the nail but signs of psoriasis on other parts of the body would at least indicate the possibility of the affection caused by psoriasis Microscopic examination of the nail under a sodium sulphide preparation *will* clinch the diagnosis in a case *of ringworm For this the coverslip preparation* of the material with sodium sulphide solution is *kept* for about three hours with heating of the solution at *intervals After that period the material becomes* soft and is pressed gently under the coverslip to spread it It is then examined under the low power and confirmed under the high power Mycelia often show a beaded appearance due to formation of arthrospores

Culture of the material is best done in Sabouraud s medium with gentian violet This prevents the gross *contamination and creates a favourable condi*tion for the growth of the fungus

Treatment No local treatment is satisfactory except avulsion of the nail *under nitrous oxide anaesthesia* Thorium X varnish has been claimed to have given very good results Application of Castellani s paint twice daily when continued for *about six months may* cure the condition In some cases For this the nail is scraped to such an extent that the affected tissue is almost completely removed *before the paint is applied*

PLATE XXXI

RINGWORM OF THF NAIL AND HANDS









The ff te l n ls show typical moth eat n appearan e The sk n on the do sal a pect of the h nd show a c ndit on of hype kerato is (lowe left) The commonest o gan m in Ind a is T pu p e m (T b m)

PLATE XXXII

FAVUS (Scalp)









Favus cau ed by—(a and b) *Ach r* [illegible] *cl o nlei* (c) and (d) *A orton*

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FAVUS (Tinea favosa)

Favus is an infection of the hair and skin caused by *Achorion schoenleini* In Japan it is caused by *A schoenleini* and *A schoenleini* var *mongolica* but in India favus is caused by *A actioni* and an organism allied to *A schoenleini* var *mongolica* (unpublished) It may affect a person of any age but children are usually victims of this disease It usually invades the scalp but glabrous skin nails or mucous membrane may be affected The fungus gives a typical mouse like odour In India the disease is commonly seen in Kashmir Punjab and Rajputna but does not occur in the eastern and southern parts

Symptoms On the scalp the lesion begins as small yellow sulphur coloured cup shaped discs around the hair follicle called scutula The concavity of the cup is upwards When a disc is removed it leaves an oozing ulcerated area which is red with seropurulent discharge The scululum increases in size and coalesce with the adjacent ones Thus in an advanced case the whole scalp appears to be covered with a thick yellow coloured mud plaster (Pl XXXII) The lesion spreads from the scalp to the body and form scutula along the lanugo hairs Nails are similarly involved showing the same type of thick deposit of the fungus mixed with dry secretion debris epithelial cells and leucocytes

Diagnosis Kerion may be mistaken for favus When the scutulum is dissolved in sod sulphide solution and examined under the microscope it is found to contain a network of mycelial threads in which there are epithelial debris and pus cells In the hair which pierces the scutulum mycelia are arranged along the long axis and hence the hair splits longitudinally and do not break

Prognosis In the scalp it is very difficult to eradicate the disease but favus of the glabrous skin is more amenable to treatment

Prophylaxis Favus is highly contagious and complete segregation of the patient is imperative Hats turbans or other head dresses should be burnt and tight fitting washable cotton caps must be worn and boiled daily for disinfection till the patient is completely cured

Treatment Scutula are removed with 10 per cent salicylic acid or 2 per cent mercuric oleate ointment Epilation of the hair with X rays is advisable and the scalp is then treated with thymol iodine paint Chances of baldness resulting from the disease are much greater than from X ray treatment If the nail is affected it should be removed and the nail bed is treated as for ringworm of the nail

TINEA IMBRICATA

Synonyms Tropical ringworm Tokelau and other local names

Definition Tinea imbricata or tropical ringworm is caused by *Trichophyton concentricum* and characterised clinically by the presence of extensive, flaky tissue paper like concentrically arranged scales

History The disease was first described by Dampier in 'Voyage round the world' published in 1789 Tilbury Fox described the disease in 1874 as Tokelau ringworm but he considered the fungus to be identical with that of European ringworm Manson (1879 82) was the first to describe the disease in china in any detail and he gave the name tinea imbricata He considered *the fungus to be a non cultivable trichophyton to which Blanchard gave the* name *Trichophyton concentricum* Castellani in Ceylon (1910 11) was the first to cultivate the fungus and proved it to be the causative organism by successful inoculation in human volunteers

Etiology and pathogenesis The infection is found in all age groups including children Both the sexes are equally affected The fungus infects the glabrous skin but hair or the hairy scalp is not affected The fungus grows between the superficial layers of the epidermis *forming a felt of interlacing* mycelia which detach the horny and granular layers from the rete

Geographical distribution The disease occurs commonly in the Malay Peninsula South Pacific Islands Southern China India Ceylon South Africa and Central America In India it is very common in the aboriginals and tribal population of Assam residing in the submountainous regions namely the Mikirs Garos Khasis Ravas Nagas and Aborrhs (Dey and Maplestone 1941) and rarely in the planes The disease was described by Acton and Ghosh (1934) in a Bengali inhabitant residing in the plane at the foot of Garo hills

Signs and symptoms The disease begins either in the trunk or in any of the limbs as a round or oval pigmented macule which is very irritable The *macule soon breaks in the centre forming a ring with the scale attached to* their outer margin The ring extends at the periphery and increases in size and another similar macule starts and a ring forms inside the first one In this way a large patch is formed containing several concentric rings of scales The arrangement of the scales has been very aptly compared by Manson with ripples produced by a stone thrown into a pool of water Similar lesions *follow on other areas and several systems* or concentric rings appear which overlap one another A fully developed lesion presents a system of parallel wavy lines which at the first glance creates an impression that a complicated series of figures has been tatooed on the skin The undulating parallel lines appear like the imbrication of tiles on a roof and hence the term tinea imbricata *The flaky scales often stick out like tissue paper* in such cases The entire skin surface of the body may be affected except the axilla groin and scalp palms of the hands and soles of the feet The nails when affected become brittle and friable Irritation is usually severe but there is seldom any secondary infection or inflammatory changes *(Pl XXXIII)*

Diagnosis The disease may be diagnosed clinically by the concentric or parallel rings of scales which often resemble ripples when a stone is thrown in a pool of water The body is extensively involved in this condition The finding of mycelial elements on the scales clinches the diagnosis The

PLATE XXXIII

TINEA IMBRICATA






Concentric rings are seen in the upper left and parallel wavy lines in the lower left figure

PLATE XXXIV

MYCETOMA CAUSED BY *GLENOSPORA SEMONI*



(a) Mycetoma of the foot (b) Culture on Sabouraud's maltose agar (3 weeks old)
(c) Microculture showing chlamydospores

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fungus can be demonstrated in scales in a coverslip preparation with sodium sulphide solution Culture is necessary for identification of the species but primary culture does not give uniformly positive result unless the material is properly selected

Treatment No satisfactory treatment of tinea imbricata is known as yet Strong keratolytics like 10 per cent chrysarobin or 5 per cent each of sulphur *precipitate and salicylic acid in vaseline or 2 per cent* derobin in an ointment base show a very good effect but results are temporary and lesions reappear within a short time Castellani s paint has been recommended and this may be supplemented with Whitfield s ointment A pigment containing resorcinol—dr i acid acetic—dr i and tincture benzoin co oz 1 may be applied with some benefit Ringworm paint is more effective bu may irritate the tender skin

Dermatophytides (id or ide lesions)

Dermatophytides are eruptions due to dissemination of mycelia spores or any allergen produced by the fungus from a primary focus of infection in the body followed by sensitisation of the skin

Various clinical types have been described namely papular vesicular pustular eczematoid or rarely of the type of frank erythema multiforme The commoner is the lichenoid type in which groups of conical follicular papules appear symmetrically on the trunk and extremities Fungi are present in the primary focus but can not be demonstrated in the ide lesions

Dermatophytides usually occur in acute lesions caused by ringworm fungi of animal origin e g *M gypseum M canis* and *T mentagrophytes* and sensitisation can be demonstrated by a positive reaction to trichophytin Epidermophytides may be produced by *E floccosum* in the form of pompholyx of the hand originating from a primary focus in the foot

Treatment The treatment of dermatophytides is symptomatic They disappear spontaneously when the primary focus is treated

GLENOSPORA

GLENOSPORA GRAPHII Siebermann 1889

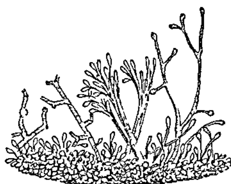


Fig 37—*G g ph* show ng terminal conid a 14

Glenospora are characterised by large aleuriospores 10 μ or more in diameter Mycelia are white at first and later dark and brownish in colour The filaments are septate 2 to 3 μ in diameter ramified Fertile hyphae are erect with terminal conidia which are small (5 μ or less) ovoid with smooth surface greyish brown in colour (Fig 37) They grow in ordinary media gelatin is not liquefied

G graphii has been found in cases of otomycosis and keratomycosis

GLENOSPORA KHARTOUMENSIS Chalmers and Archibald, 1916

G khartoumensis was found in a case of black mycetoma at Khartum in Anglo Egyptian Sudan

Morphology They show branched septate hyphae 2 8 to 1 4 μ in diameter The hyphae are darker in old cultures They from thick walled dark coloured chlamydospores (14 by 11 μ) forming black masses on the surface of potato infusions and nutrient gelatin Aleuriospores are seen acro pleurogenously on the surface growth of old potato infusions They are 5 μ or less in diameter

Culture The optimum temperature for growth is 30 C It grows well in carrot as well as in glucose maltose or nutrient agar It does not liquefy coagulated serum or gelatin In litmus milk it grows well and forms a flaky precipitate On maltose agar it gives a typical dusky drab growth and with a central elevation with radiating furrows and firinges at the margin

Pathogenicity It causes African black mycetoma in man but inoculations have failed in laboratory animals under different experimental conditions by various routes

GLENOSPORA SEMONI Chalmers and Archibald 1917

This organism was isolated by Semon from a case of black maduromycosis occuring in an indian soldier serving in France It has been recently isolated in India by Kakoti and Dey 1956 from a case of black mycetoma

G semoni closely resembles *G khartoumensis* and may be considered synonymous with the latter It slightly differs from *G khartoumensis* On maltose agar the culture is characterised by a smooth surface instead of a central depression or nob with radial furrows and fringes at the margin (Pl XXXIV Fig C)

Pathogenecity *It causes Asian black mycetoma of the foot in man*

GENUS ACLADIUM Link 1809

Suborder Aleuriosporineae family Aleurismaceae tribe Aleurismae

In culture the mycelia are thin and pale with acladium type of aleuriospores which are appendiculate and borne pleurogenously

ACLADIUM CASTELLANI Pinoy 1916

The organism was found by Castellani in Ceylon and Greece It has also been reported from China and Malay States It causes ulcers anywhere in the skin with furuncles or nodules or broncho acladiosis (Castellani)

Culture Colonies are round Mycelial filaments are about 2 μ in diameter The chlamydospore are terminal (acrogenous) Aleurispores are 4 by 3 μ often lateral (pleurogenous) and rarely terminal (acrogenous) (Fig 38)

Treatment The lesions are not spontaneously cured but *improvement occurs* when cases are treated with potassium iodide per mouth



Fig 38—A castellani (a) conidia (b) development of mycelia (c) chlamydospores

REFERENCES

Acton H W and McGuire C Tinea cruris: Its manife tation diagno i an l treatment *Ind an Med Gas* 72 419 19 7

Acton H W an l Ghosh I M Tinea iml ricata (Tokelau) in Bengal *Ind M d Gas* 69 4 6 1934

Dey N C A review of ringworm of tl e hair in In lia *Ibid* 88 194 1953

Id m *T ich phyt r p pu m* infection in India *Ibid* 88 *5 1953

Dey N C and M plestone P A Ringworm of the s alj in in lia *Ind M d G s* 70 541 1935

D y N C Maplestone P A Favus in India *Ind J Med Re* 23 68 1930

Id m A mi rosporum new to In lia *Ind M d Ga* 74 148 193J

Id m *T l phyt n er t f me* in In lia *Ibid* 76 410 1491

I l m Tinea in bricata in Ind a *Ib d* 77 14 194

Dey N C an l Ghosl L M Studies in r ngworm Part I *M cr p m ud* infection in India *Ib d* 80 381 1945

Id m Stu li s in r ngworm Part II Tl rapy of t nea caj itis l y gona lotrop c l ormone 80 381 194

Gl o h L M Dey N C and I anja D Studies in ingworm part IV *Ibid* 81 3 194

Dey N C Kakoti L M *M p m g p m* in India *J Ind M d As oc* 25 160 195

Id m Favifo m ctoth ix t i l opl yto is in India *I d J De m t l gy* 1 3 1950

Kakot L M Dey N C Mycetoma c used l y *Gl p a s m i I d J M d* is 10 889 19 6

Castell ni A and Chalmers A J M nnual of trop cal medi ine Bailler Tind ll and Cox London 1919

Cast llani A Fungi and fungus d seases *Arcl D m t* 17 354 19 9



CHAPTER X

SUBORDER SPOROTRICHINEAE

SPOROTRICHOSIS

Definition Sporotrichosis is a subacute or chronic granulomatous lesion of the skin caused by *Sporotrichum schenckii* characterised by gummatous ulcers of the skin and subcutaneous tissues bones and viscera including the central nervous system Spread occurs by extension along the lymphatics and rarely by the haematogenous route

History Schenck (1898) first isolated and described a fungus in Baltimore from a patient with a subcutaneous abscess on the arm and placed it in the genus Sporotrichum Hekton and Perkins (1900) reported a second case in U S A and called the organism *Sporothrix schenckii* Beurmann and Ramond (1903) found a similar infection in France and Matruchot and Ramond (1905) called the causative fungus *Sporotrichum beurmanni* Several other species have been described from many parts of the world but they are now considered to be variants of *S schenckii*

Geographical distribution The disease is common in U S A and France du Toit (1942) reported 650 cases of sporotrichosis occuring in the gold mines of South Africa Twelve cases were recorded in the skin out patient department of the School of Tropical Medicine Calcutta during a period of 15 years and of these detailed studies of two cases were reported by Ghosh (1932) and Panja et al (1947)

The fungus is widely distributed in nature and it has been recovered from plants and timbers in mines by du Toit Spontaneous infection occurs in horses rats cats dogs and rabbits Meyer (1915) found that the organism was present in the hair and skin of healthy horses coming in contact with the diseased ones

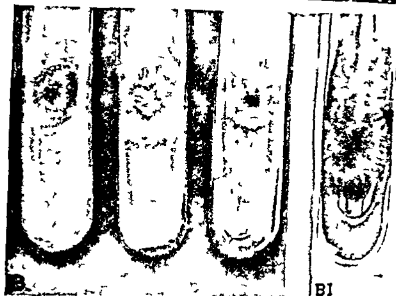
Etiology The disease may occur at any age Males are more frequently affected than females The disease is specially seen amongst farmers gardeners mine workers and horticulturists Persons coming in contact with horses and cattle are liable to contract the disease Man may be infected through wounds coming in contact with plants and du Toit observed that mine workers might contract the disease from infected timber

Organism The causative organism of the disease is *S schenckii* In France *S beurmanni* was found to be responsible to cause sporotrichosis Panja Dey and Ghosh (1949) described a new species and called it *S tropicale* There has been a considerable discussion about the validity of the plurality of species on the basis of growth characters in different media sugar reactions disposition of conidia etc Davis has however shown that both the pigment and spore formation are too variable to be used as points for differentiation because both these depend on nature of the medium and frequency of subculture Meyer and Aird (1915) again showed that different isolates vary in their biochemical reactions and most strains liquefied gelatin slowly Therefore workers are in favour of recognising a single pathogenic species namely *S schenckii*

PLATE XXXV

SPOROTRICHOSIS







(A) Gummatous ulcer of the right arm and forearm (B) Culture of *Sporotrichum schenckii* (3 weeks old) and B1 (6 weeks old) (C) Conidia of *S. schenckii* in hanging drop culture

To Face Page 109

Signs and symptoms The incubation period is 3 weeks to three months The primary lesion may appear on the hand arm or foot where the fungus is introduced throgh a wound The lesion starts as a hard inelastic non adherent movable nodule which undergoes softening necrosis and ulceration resulting in a gummatous ulcer often called sporotrichotic chancre Six clinical types have been described by Beurmann and Gougerot namely (1) lymphatic (2) disseminated (3) epidermal (4) mucosal (5) skeletal and (6) visceral according to the site involved From the site of primary infection the fungus spreads along the subcutaneous lymphatics The lymphatics draining the area show subcutaneous nodules along the lymphatic vessels which become cord like These secondary nodules soften and form abscesses some of which burst forming indolent gummatous ulcers (Pl XXXV) This type of infection is common in U S A Disseminated type is commonly seen in France and suggestive of haematogenous spread of the disease No primary le ion is evident in this type and the onset is insidious The first symptom noted is the presence of subcutaneous nodules scattered all over the body These nodules contain viscid pus and rarely ulcerate In the spreading type the infection may be insidious but multiple subcutaneous nodules burst and form tuberculoid syphyloid or ecthymiform lesions Mucosal lesions may be primary or secondary to dissemination through haematogenous route producing lesions also in viscera and brains In the epidermal type there is extensive involvement of the skin with various types of lesions namely nodules either ulcerative or non ulcerative infiltrating plaques verrucose or papillomatous lesions

Histopathology Lesions show only a non specific chronic inflammatory process similar to those in tuberculosis and syphilis The granuloma shows infiltration with lymphocytes plasma cells gaint cells and fibrosis The method is therefore not useful for diagnosis Fusiform bodies are usually absent in the section but may be seen in smears of pus



Fig 39—Con d a of S he k in culture

Mycology The fungus is dimorphic namely (a) tissue phase showing fusiform bodies and (b) filamentous form in culture It is difficult to demonstrate the fusiform bodies in the pus They are 1 5 by 4 μ and present in the mononuclear or polymorphonnclear leucocytes

Culture The organism is better demonstrated by culture The material is usually obtained from a nodule by incising it and tubes are inoculated and incubated at room temperature and in the incubator Both blood agar and Sabouraud s agar should be used for culture The primary culture appears in Sabouraud s glucose agar within 4 to 7 days but it may be delayed upto 10 days It is at first creamy

and light brown in colour with an uneven leathery corrugated surface With the age of the culture the colour becomes dark brown and the growth becomes wrinkled in the centre with radiating furrows Excrescences appear in the centre of old cultures (Pl XXXV) Subcultures on cystine agar at 37 C shows soft yeast like fusiform bodies

Microculture Branching mycelia are seen extending on all sides with terminal and lateral conidiophores bearing conidia Conidia are pyriform varying from 4 to 8 in number and may form a rosette in some cases (Pl XXXV and Fig 39)

Biochemical reactions Most of the strains liquefy gelatin They show variable sugar reactions with formation of acid

Animal inoculation Most of the laboratory animals specially white rats and mice are susceptible and the intraperitoneal inoculations in rats produce acute inflammation of the testes

Immunological rection Agglutinin has been demonstrated in patients and in experimental sporotrichosis Spore suspensions are agglutinated in 1 in 600 dilution of patient s serum but sera of patient s suffering from actinomycosis may agglutinate spores of sporotrichum (Widal 1910) Moreover the agglutina tion test is difficult as the spores have a tendency to spontaneous agglutination and normal sera may also agglutinate the spores in a variable titre Intracutaneous test with an extract of sporotrichum is positive in infected subjects and a negative result excludes the infection But occasionally false positive reactions are seen

Diagnosis Fusiform bodies found in experimental animals are rarely found in materials from human lesions Positive culture from the pus of an unruptured abscess or biopsy material is the best method of diagnosis The cultures are taken in blood agar and Sabouraud s glucose agar and incubated at room temperature and at 37 C *S schenckii* is identified by the characteristic colony with typical spore formation

Treatment Potassium iodide orally for a long period cures the disease The drug should be continued for one or two months after the patient is apparently cured Iodide resistant cases may respond to sulphonamide therapy

REFERENCES

du Toit C J — Sporotrichosis on Witwatersrand *J Tr ... Med 10ff Asia* 22 111 1942

Ghosh L M — *Ind Med Gaz* 67 670 1933

Hekton L and Perkins C F — *J Exp Med* 5 1900

Matruchot L and Ramond L — *Compt rend Soc Biol* 59 379 1905

Meyer K F and Aird J A — Various sporotricha differentiated by the fermentation of carbohydrates *J Infect Dis* 16 399 1915

Panja D Dey N C Ghosh L M — Sporotrichosis of the skin in India *Ind Med Gaz* 82 00 194

Schenck B R — On refractory subcutaneous abscesses caused by a fungus possibly related to sporotricha *Bull Johns Hopkins Hosp* 9 86 1898

CHAPTER XI

CLASS ASCOMYCETES

ALLESCHERIA BOYDII

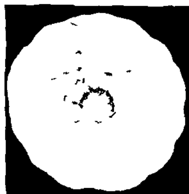
(The asexual phase being Monosporium apiosperum)

Synonyms *Monosporium apiospermum* Saccardo 1911 *Scedosporium apiospermum* Saccardo 1914 *Glenospora clapieri* Catanei 1927 *Indiella americana* Delamare and Gatti 1929

Definition *Allescheria boydii* is the perfect stage of *Monsporium apiospermum* causing mycetoma in U S A characterised by formation of white or light yellow granules constituted by wide septate hyphae in the tissue or exudate draining from the sinuses

History Although there are several previous records of mycetoma with white granules in U S A the first case to show a positive culture was one reported by Boyd and Crutchfield (1921) In the culture of the fungus they found conidial stage and ascospores The fungus was called *Allescheria boydii* Shear (1922) Emmons (1944) demonstrated that *A boydii* was the perfect stage of *Monosporium apiospermum* isolated from cases of maduromycosis in U S A

Symptoms The fungus causes mycetoma of the foot in U S A with multiple discharging sinuses The granules are white to yellowish white in colour It may cause bony destruction of metatarsals or phalanges of the foot like those caused by Nocardia group in general but the latter produces bone destruction more than *A boydii* or other types of infecting fungi



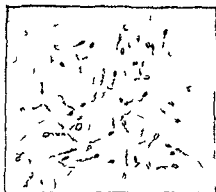


Fig 40—*A boydii* left—giant colony right—conidia in culture

Histopathology The lesions are like those of maduromycosis and formation of abscesses and sinuses is the prominent feature The granules are surrounded by polymorphonuclear neutrophils plasma cells lymphocytes eosinophils and macrophages Giant cells are often present The granules are spherical or lobulated and composed of thick septate hyphae with chlamydospores

Culture (Fig 40) *M apiospermum can be cultivated in ordinary media* In Sabouraud s glucose agar the colony develops rapidly as a white downy aerial growth which later becomes greyish to buff in colour A black pigment is often seen on the reverse side of the growth

Microculture (Fig 40) Microscopically the organism shows mycelia having single ovoid to clavate conidia with truncated base held at the end of conidiophores of various lengths Corremia are sometimes seen with conidia at the end of conidiophores Pleurogenous spores are also seen in certain strains

In the ascomycetes phase of *A boydii* the sexual spore is characterised by a cleistothecia (closed perithecia without osteole) 50 to 200 μ in diameter and thin walled They contain a brownish structure containing subglobose asci in each of which 8 ascospores 4 to 4 5 μ by 7 to 7 5 in size are present As monosporous stage is the imperfect stage of *A boydii* it is better to call the fungus *A boydii*

Animal inoculation Laboratory animals are not susceptible Injection of a pure culture into the knee joints or feet of animals may produce only temporary lesions

Diagnosis Granules that escape through the sinuses are characteristic They are white or yellowish white in colour Under the microscope mycelia are 2 to 4 μ in diameter and show chlamydospores at the periphery After washing several times in sterilised normal saline the granules can be broken into small pieces and cultivated on Sabouraud s or beef infusion glucose agar and incubated at room temperature Cultures should be kept for sufficient time for the growth which may be delayed

Treatment Sulphonamides or antibiotics have not proved to be successful and the infected limb is to be amputated

ASPERGILLUS

General characters The genus is characterised by formation of conidia borne on conidiophores which are unbranched non septate erect aerial hyphae arising from foot cells growing on the substrate Conidiophores form swollen vesicles at the tip which bear small flask shaped sterigmata Conidia are formed by a process of abstriction from the tip of the sterigma forming an unbranched chain The proximal conidium is the youngest and the distal one is the oldest The conidia are often prickly in appearance and disperse easily with the slightest disturbance (Fig 41)

Some Aspergilli show formation of loose perithecia which contain asci and ascospores and are called Erotium (under Ascomycetes) whereas Aspergillus is classified by many *under Conidiosporales* (Fungi Imperfecti)

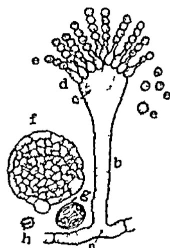


Fig 41—*Aspergillus* (a) Foot cell (b) Conidiophore [illegible] Vesicle (d) Sterigma [illegible] Conidia (f) Perithecium containing asci [illegible] Ascus (h) Ascospore

Lesions *Otomycosis* is caused by *A niger* or *A flavus* and is likely to be secondary to bacterial infection of the ear caused by *Pseudomonas aeruginosa* and the fungus exists as a saprophyte in the macerated tissue or ear wax It may cause irritation or unbearable pain in the ear *Maduromycosis* is caused by *A fumigatus* which has been isoloted from the lesion It is characterised by formation of black granules It may produce a condition of bronchitis but it often occurs as a secondary invader in carcinoma of the lung brochiectasis or tuberculosis Primary infection of the lung may simulate tuberculosis with chronic cough and mucopurulent discharge often containing blood X ray examination may show nodular or diffuse lesions resembling patchy bronchopneumonia abscess of the lung or cavitation

Diagnosis The organism is ubiquitous in its distribution and it is therefore difficult to ascribe the pathogenicity to a strain isolated from any natural orifice of the body or from sputum of the patient with pulmonary infection Usually mycelial fragments are seen but conidiophores may be seen on rare occasions Conidiophores are diagnostic but when mycelial fragments are seen the growth of Aspergillus must be obtained repeatedly from the material by culturing the material on Sabouraud s glucose agar

PENICILLIUM

Penicillium is ubiquitous in distribution and often seen in rotten or decaying organic matters and it is one of the commonest food moulds often seen in fruits They often contaminate laboratory culture media

The fruit bearing organ is a conidiophore an aerial hypha bearing conidia and forming finger like branches resembling a hair pencil hence the name The conidiophore shows primary verticillate branches which on further subdivision form flask shaped sterigma abstricting at their tips chains of conidia (Fig 42) Owing to its universal distribution in the laboratory it is difficult to ascribe the pathogenicity of any of these organisms isolated from the lesion Different species of penicillium have been isolated from otomycosis and pulmonary abscesses Penicillin is produced by *P notatum*

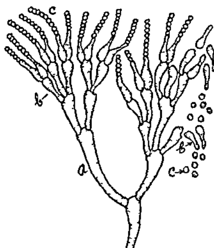


Fig 42—Penicillium (a) branching of conidiophore (b) sterigma (c) conidia

CHAPTER XII

CLASS PHYCOMYCETES

Order Mucorales Family Mucoraceae

Organisms of the family Mucuraceae are commonly known as *bread moulds* and are generally found in mannured soil including horse dung heap *fruits and* starchy food staffs The non septate vegetative mycelia produce globose *sporangia borne* on sporangiophores which form columella at the end They reproduce sexually by formation of zygospores They are differentiated from fungi imperfecti by their coarse non septate mycelia and loose aerial hyphae The following genera are commonly encountered

Mucor They show abundant floccose aerial mycelia at first white and then dark gray Rhizoids are absent sporangiophores are *simple or branched* and arise from any part of the thallus Spores are smooth and *regular round* oval or pear shaped Sporangia are single multispored and borne on the conidiophores forming columella round or cylindrical in shape (Fig 43) Common species—*M mucedo*

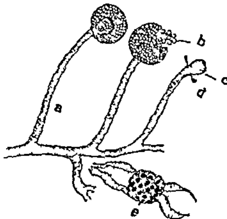


Fig 43—Mucor mucedo (a) Sporangiophore (b) Sporangiospores (c) Columella (d) Apophysis (e) Zygospore

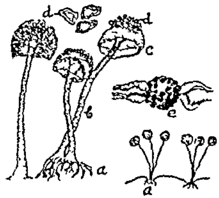


Fig 44—Rhizopus (a) Rhizoid (b) Sporangiophore (c) Sporangium (d) Sporangiospores (e) Zygospore

Rhizopus They form dense colonies mycelia are at first white and then dark gray They spread over the substrate by stolons or runners which connect a group of unbranched sporangiophores held by a tuft of root like hyphae or rhizods Unlike Mucor after dehisence of the spores columella are mushroom like and rest on a cup shaped expansion called *apophysis* Spores are angular (Fig 44) Common species are *R niger R parasiticus*

Lichtheimia In this genus mycelia are non ramified with or without rhizoids peduncle supporting the sporangium terminates in a structure encircling the base of the columella Species *L corymbifera (Mucor corymbifer)*

Rhizomucor These are mucor like but rhizoids are present and columella are ovoid in shape

Mucormycosis NOSE *M corymbifer* has been isolated from mycosis of the nose but its pathogenicity has not been definitely established TONGUE *Rhizopus*

niger has been isolated from black tongue EAR Various species of mucor have been incriminated for causing otomycosis NAILS Species of mucor have been isolated from cases of paronychia in orange workers

LUNGS AND MENINGES Several cases of primary pulmonary mucormycosis with metastatic abscesses in various organs of the body before death have been recorded Meningeal infection and abscesses of the brain caused by species of Mucor have been recently reported

RHINOSPORIDIOSIS

Definition It is a chronic fungus infection caused by *Rhinosporidium seeberi* chiefly affecting the mucous membrane of the nose characterised by a polypoid growth Cheek uvula lachrymal sac conjunctiva ear and mucous membranes of other parts of the body may be affected with formation of polypoid growths

History Seeber (1900) reported two cases of nasal polp caused by a protozoal infection The organism was called *Coccidium seeberi* by Wernicke (1903) belonging to sporozoa The third case was reported by O Kinealy (1903) in India and the organism was called *Rhinosporidium Kinealyi* by Minchin and Fantham (1905) Seeber (1912) found this to be identical with his organism and called the organism *Rhinosporidium seeberi* Since then more cases were published from various parts of the world The organism was thought to be a protozoa untill Ashworth (1932) demonstrated the morphological similarity of the fungus with Chytridales(Phycomycetes) The organism has not been cultivated as yet and the taxonomic position of *R seeberi* still remains doubtful

Geographical distribution The disease is endemic in many parts of India and Ceylon It has been reported from Mexico Argentina and other parts of South America U S A Malay States Persia Italy Philippines and United Kingdom

Etiology Infection may occur at any age but is commonly seen in children and young adults Males are more often infected than females and divers are frequently infected Those who dive swim or wash their face in stagnant water are usually infected Karunaratne (1939) considered its transmission to be due to the custom of cleaning the nose in a common basin before entering the temple

Source of infection The organism has not been cultured or transmitted experimentally to man or animals The disease occurs spontaneously in horses cows and mules It has been suggested that it is primarily a disease of fish and man and animals contract the disease accidently from infected water

Symptoms In rhinosporidosis polypoid or papillomatous growth occurs on the nasal mucosa either sessile or pedunculated They vary in colour from a pale pink to purplish red Multiple minute white granules are seen on the surface of the new growth representing sporangia Lesions may be seen in the eye and may affect the bulbar or palpebral conjunctiva eye lids producing papillomatous growths giving a foreign body sensation Penile lesions appear as cauliflower like growths resembling venereal warts There is no subjective symptom except that it causes inconvenience due to the growth

Histopathology The polyp cosists of a vascular myxomatous connective tissue and contains *sporangia (Fig 46) with* empty chitinous shells which may *produce granulomas* with foreign body giant cells sometimes with small abscesses

Mycology *The* fungus is characterised by formation of sporangia 0 25 to 3 *mm with a* pore *It* contains a large number of spherical or oval spores 6 to 7 μ *in diameter* with chitinous walls (Fig 46) They have vacuolated cytoplasm and a vesicular *nucleus with a karysome* Spores escape by rupture of the *sporangium at the* pore and are carried through the connective tissue to the lymphatic channels The culture is not yet successful

Animal inoculation Experimental inoculations in laboratory animals are not successful

Prognosis The disease is rarely fatal although lesions may sometimes cause mechanical obstruction or deformities by their growths

Treatment Surgical removal of the polyp should be done with a wire snare Intravenous administration of antimony has been recommended and pentavalent antimony compounds intravenously upto a total dose of 2 to 4 gm may be helpful as an adjunct to surgical measures



Fig 46—Left—Section of a nasal polyp showing various stages of development of sporangia X 80 Right—Escape of spores by rupture of a sporangium through the pore X 430

REFERENCES

Boyd M F and Crutchfeld F D *Amer J Trop Med* 1 215 1921

Emmons C W *Mycologia* 36 258 1944

Shear C L *Mycologia* 14 239 1922

APPENDIX A

SOLVENTS AND STAINS FOR DIRECT EXAMINATION

Sodium sulphide solution To prepare a saturate l sol ition put a few drops of d stilled wat r t tystal of M rck so l um s lj hi le Take a volum of th s solution ld an equal vol ime of rectifi d spirit or 90 p r cent alcohol on mixi g turb dity appears Add a few lrop of d stilled w ter till tl e turbidity lis ppear Tl e s l ition is th n f ltered with a filter paper Tl e l st r ilt is obtaine l wl n a freshly prepare l solution is u e l But for all practical p irj ose tl ol t on can l e u e l in a lrop bottl fo one month witho t any deterioration

Potassium or sodium hydroxide solution A 10 p r cent olution of j tass m or od um hydro le s il ition is u ed as a ker itolyti agent For na ls i se a 40 per cent solut on

Sodium sulj hi le sol ition l as l cen found to be th be t of all tl e keratolytic g nt and in tl e cj nion of tl e auth r tl s is better than pot is um or o lium hydroxid solutions

McGuire s stain		Carbol thionin		Borax methylene blue	
Tolu d n l lue 1 gm		Tl ionin	1 gm	Methylen bl e	gm
Al ol l	c	Phenol ryst il	gm	Borax	5 gm
Acetic a i l	4 c c	Al ol ol	30 c c	Wat r	100 c c
Wat r	100 c c	Wat r	100 c c		

Thin scales l ke th o of tinea v icolor erythra m j ity riasi cap tis may be placed in a slide and treated with a few drops of McGuir sta n or carbol thionin for min tes Tl e stain is then mopped off with a piece of f lter j aper an l a coverslip p paration is made with a drop of gly erine which g ves a differentiating eff ct on the staining of the fungus For scale of pityrias s capitis the scal s are treated w th etl er or acetone for removal of fat l fo e they are treated with tl e stain Borax or any otl p lycl ome methyl e blue sta n n y g ve a satisf tory result in this cas

Amman s Lactophenol (Modified)

Phen l c y tals	0 gm	L ict aci l (y up)	20 gm
Glycer n	0 gm	Cotton Blue	0 05 gm
Wate	0 c c		

All the ing ed nt ex ept cotton bl ar d olv l with gentle l eating Cotton bl i tl add l an l it d olve in no time Aci l fucl sin may be ul stitut l for cotton blue with n equally good re ult and it give a l colour instead of a blue one Tl sta n i extr m ly f il for tl cultur mount For th s h nging l op or aga ultu e i tea ed w l ed in ater to r mo e trac s of ag ir Tl e culture tl en mounte l in Amm n lactoj l enol in a ove lij l r p rat on Exce of the stain is r move l by soak ng w th f lte p per an l the preparat on i then ale l w tl c itex nail pol h on all s des

COLLECTION OF MATERIAL

(For ringworm t n a versicolor etc)

Eq p t (1) Pa rs of slides wrapped in craft paper and t rilised n a l ot a oven (2) Ether and al ohol m xtu e in equal volum (3) Swab of cotton wool (4) Paget s knife (5) Ep lat on forceps (6) Spirit lamp etc

Th following points are ecord d in the reg te n mely —name ag ex date of ollectio d rat on of illness site f om which the mat l s oll cted l n al d gnos esult of direct x m n t on culture eport and remarks

Scraping from the glabrous skin Th s is lon for d t e am t on of th scale and th iltu e The pa t to be crape l i cleane l and ster l d w th a wab of th and alcohol

mixture The Paget s knife is dipped in ether alcohol mixture and passed through the Bunsen burner or spirit lamp and thus the excess of *spirit is burnt The sterilised knife is used* when cool The scraping is usually done from the margin of the lesion without injuring the skin surface This is done by scraping with the blade kept flat on the skin and not in an angular fashion The slide should be held in such a way that scales obtained by scraping may be received directly on the slides When sufficient material is collected the second slide is put on the *first one on which the material was received The slides are* wrapped back in the craft paper The serial number in the register is put down on the cover

Collection of material from pompholyx Boiled sago grain like blisters on the palm of the hand (Cheiropompholyx) or sole of the foot (Podopompholyx) are due to ringworm infection or id reaction In the former case ringworm fungus is present and the skin from *the blister shows ringworm fungi but in the latter* instance no pathogenic organism can be detected For collection of material from blisters a pair of scissors is similarly sterilised The point of the scissors is introduced into the blister at its edge and the skin over the blister is cut at the periphery in a circular fashion *holding the margin of the skin with a pair of dissecting forceps* The cut portion of the skin is received in between a pair of sterile *slides Skin from several blisters* may be collected in this way for direct examination and culture

Scraping from the nail Nails are liable to be attacked by ringworm fungi The affected nail becomes opaque brittle and hypertrophied Nails may also be affected by favus Collection is made by shaving the nail bed with a Paget s knife or with a hard safety razor blade *The material is received directly on the slide Other procedures are the same* as in the scraping of the glabrous skin

Collection of infected hair In ringworm of the scalp or beard area infected hairs are collected for direct examination and culture This is conveniently done with the help of a pair of epilation forceps It should be emphasised that stumps of infected hair are small and the epilation in such cases is not at all painful This fact should be borne in mind and if the epilation is painful it should be presumed that the epilated hair is healthy [illegible] quite loose in the widely gaping hair follicles in cases of kerion of the scalp and fine [illegible]

CULTURE MEDIA

Sabouraud s proof medium

Maltose (brute de Chanut)	40 gm	Peptone (granulee de Chassaing)	10 gm
Agar agar	3 gm	Distilled water	1000
		pH [illegible]	

For the study of giant colonies the above formula should be strictly followed because a slight difference in the composition of the medium or *changing the brand of the ingredients* may alter the character of the growth of the giant colony In the tropics the quantity of agar should be increased

In Italy Pollacci and in Germany Grütz media are used as a substitute for Sabouraud s medium In America Weidman and Spring showed that Fairchild s peptone could be substituted for Chassaing peptone without any *difficulty or sacrifice in the final result* It was also demonstrated by Weidman and McMillan that crude American dextrose could act as a substitute for crude maltose de Chanut used in the original Sabouraud s medium It was later found that technical dextrose gave equally good results

Weidman s modification of Sabouraud s medium

Agar (granular)	18 gm	*Peptone (Fairchild)*	10 gm	
Dextrose (American crude)	40 gm	Water	1000 c	pH 6

Preparation of Sabouraud s proof medium Mix the ingredients in a flask and allow the mixture to stand for half an hour Then place the flask in the autoclave Raise the temperature of the autoclave till a continuous jet of steam is coming out through the stop cock The stop cock is then closed and the pressure is raised to [illegible] pounds and the [illegible] for

half an hour The gas is then turned off and when the steam has fully escaped the autoclave is opened The solution is then filtered in a hot chamber and the pH is determined at 6 2 in a Hellige or Lovibond comparator The medium is now distributed in test tubes and flasks (8 c c in a 6 by ? test tubes or 15 c c Erlenmeyer flask to give a depth of about 1 5 cm) The tubes are plugged with yellow cotton wool (the colour indicate Sabouraud's proof medium) Flask and tubes are then autoclaved For this temperature of the autoclave is raised to 15 pounds when the gas is turned off The pressure gradually falls to nil The steam is allowed to escape and the autoclave is then opened The tubes are then slanted on a slightly inclined plane and allowed to cool slowly The flask is also allowed to cool without disturbance The medium set when cool The tubes are used for routine work of isolation and subculture and the Erlenmeyer flasks are used for culture of giant colonies

C 1 As the reaction of the Sabouraud's medium is acidic too much or prolonged heating hydrolyse the sugar and prevents gel formation of agar The processing should be carried right through without allowing the medium to solidify at any stage before the slope is made Preparation of slopes by melting the stock solid medium should always be avoided as this has been found to be deleterious to gel formation and to the growth of the fungus

Sabouraud's medium with gentian violet This consists of Sabouraud's proof medium containing gentian violet in a proportion of 1 400 000 of the medium For this one percent solution of gentian violet is kept as a stock solution and 0 5cc of this solution is added to one litre of Sabouraud's proof medium This medium has been found to be very useful in preventing the growth of contaminating organisms in culturing materials like nails or c l s without interfering with the growth but the growth is delayed in this medium and i l within five to seven days

Malt extract agar medium (Difco) for culture of *P* *l* (Moore's method)

Maltose (Technical Difco)	1 75 gm	Ammonium chloride	0 78 gm
Malt extract (Difco)	1 00 gm	Bacto peptone (Difco)	15 00 gm
Dextrin (Difco)	5 gm	Bacto agar (Difco)	15 00 gm
Glycerine	2 3 gm	Water	1000 c c
Dipotassium phosphate	1 00 gm	*pH* 4 8	

Petroff's medium with gentian violet

500 gm of ground beef of veal is infused in 500 c c of 15 per cent solution of glycerine in water in a refrigerator Next morning squeeze the meat in a sterile press and collect aseptically in a sterile beaker

Mix one part of meat juice and two parts of egg by volume For this eggs are washed in soap and water and kept immersed in 70 per cent alcohol for 10 minutes Break the eggs in a sterile beaker mix and pass the mixture through sterile gauze

To the mixture of infusion and egg add one per cent alcohol solution of gentian violet to make a final dilution of 1 : 10 000 and mix the ingredients thoroughly The mixture is distributed in screw capped test tubes or bottles and sterilised by inspissation for three successive days

Panja's modification of Petroff's medium for culture of *P ov le* etc

Meat infusion in 15 per cent glycerinated water } equal parts
Content of one egg

Gentian violet—0 004 per cent slope and inspissate Meat infusion and egg are essential for the growth of *P oval*

Blood agar and nutrient agar These are prepared as in all routine bacteriological compact works

✓**Corn meal agar** Corn meal 40 gm Agar 20 gm and water 1000 c c

Mix corn meal and water and steam in Koch's steriliser for about one hour Filter through gauze and make up the volume Add agar and melt in the autoclave (5 lbs pressure for one hour) Filter through lint tube and sterilise in autoclave at 15 lbs pressure for 15 minute

N B *Candida albicans* is cultured in this medium to show production of chlamydospore

Chlamydospore agar (Nickerson and Mankowski) *This* con ists a basal medium to which purified starch is added The basal medium consists of ammonium sulphate—1 gm potassium dihydrogen pho phate—1 gm biotin— μ Bacto agar—15 gm tryp in blue—0 1 gm and di tille l water to make 1000 c c Purifie l polysacel aride is sterlised separately by autoclaving or Tyndallization) an l added aseptically to sterilised basal me lium in the proportion of gm per 100 c c Sh l cultures are prepare l in this me lium by taking *inocula from young cultures grown on glucose peptone agar* Heavy in cula are put Th cultures are incubated at C

Purification of soluble starch Add to gm of commercial olubl tarch t 100 c of boiling water When the starch i di persed and clear liqu l is still hot pour into an equal volume of saturate l ammonium sulphate soluti n (6 0 gm of ammonium sulphat to 100 c c of the solution at 2 °C) Aft r standing for 24 hours the voluminous amorphou precipitate was filtered ith suction wa hed with col l distilled water until the filtrate gav a negative te t with Ne sl r s reagent and th n lried in vacuo Th star h sol tion houl l not contain any reducing sugar as determined by Fehling s reagent With i dine it g ves a charact r istic starch or starch like reaction Some soluble starch sample l v a purpl colour with iodine indicating a high content of dextrin

Selective medium for isolation of pathogenic fungi In this me lium S ll ur u l s dextr agar i di tril ute l n 100 c c quantitie into each of the Erlenmeyer fl k an l terili e l n an autoclave a usual The flasks are then allowed to cool to 4 C in a ater bath an l antibiotics to give the final concentr tions of Cyclol eximide (Acti li ne techni al grade) penicillin and str ptomycine are then a lde l

St ck Cycl l xim ide S luti n Put mg crystalline cyclohexim le in a 50 c c volumetri flask and add 5—10 c c of acetone to dis olve it Mak up the volume with d stille l water pH of which have been adjusted to 6 — 8 sterilise by passing throug Seitz filter and store at °C This will remain stable at °C for 6—8 weeks Add 10 of stock cyclol x mi le to 100 c c of the cooled medium at 4 °C to obtain 0 mg per c

From stocl solution f treptomycin (4000 units per c c) an l Peni illin (2000 unit per c c) add 1 c c each to 100 c c of the cooled medium to gi e a final d lution of 40 an l 20 units respectively This medium has been used for isolation of *(ed l s mm i lerm itophytes from clini al materials or from sl oes and oth er extraneous sourc*

N B Actidi ne the tr de ame of y lol eximide i listr l ted l y Upjohn Comp ny Kal imazoo Michigan

MEDIUM ON A P LYSACCHARIDE ...

(L ng ron an l Milo l evit l)

Solubl starcl	10 gm
Malt se	10 gm
Glu ose	10 gm
Peptone	10 gm
Agar ag r	0 gm
Water	1000

Whe t or potato tarch h s been fo n l to be better sub titut s th an solubl ( )

ZAPEK YNTHETIC AGAR

Dipota ium hydrog n phosphate		1 0 gm
Pota ium hlori l		0 5 gm
Ma ne ium sulphate	H_2O	0 g
Fer ou ulphate		0 01 gm
Agar ag		0 gm
Di tilled wa		1 000

MEDIUM (for cultur of Nocardi)

Solubl st r l	00 gm
Dipota ium hydrog	
phosphat	0 50 gm
Magne ium ulphat	
(Hydrat l)	0 gm
Cal ium carbonate	0 gm
Ferric hlori le	0 01 gm
Sol ium n t at	0 0 gm
A paragin	0 0 gm
Agar g r	0 00 g
Distilled w t	1000 00 c c
pH to 4	

APPENDIX B

COMMON THERAPEUTIC RECIPES

LOTIONS

LOTIO ACRIFLAVINE

Acriflavine	1 gr
Aqua	ad 10 fl oz

To be applied on a gauze which should be kept soaked with the lotion 2 hrs each time and 4 times during the whole day. It is useful in streptococcal infection of the skin.

LOTIO ALUMINIUM ACETATE

Aluminium acetate	0 1 to 0 gm
Water	100 0 c

To be applied as a evaporating lotion.

LOTIO CALAMINE

Calamina praeparat	0 gr
Zinc oxide	60 gr
Glycerine	0 m
Liq calcis ad	1 fl oz

To be applied on the affected part three times daily.

LOTIO CALAMINE CO

Calamina praeparat	60 gr
Zinc oxide	40 gr
Glycerin	60 ms
Liq picis carb ... et (B P)	0 m
Liq ... let	10 m
Liq calcis ad	1 fl o

To be applied on the affected part three times daily. It is useful in acute weeping condition.

LOTIO FORMALIN ET GLYCERINE

Liq formaldehyd	m
Glycerine	60 m
Aqua ad	1 fl o

It is useful in N ... d k ... infection of the hands and feet. To apply once at night.

LOTIO EURESOL

Euresol	30
Spt ether	30 m
Ol ricini	10
Spt vini rect	60 m
Spt lavendula	1 m
Spt ... om ... n	1 ms
Aqua ad	1 o

To apply on the scalp twice daily. It is useful in dandruff (seborrhoea capitis). It does not stain the hair of blondes as in the case of resorcin.

LOTIO GENTIAN VIOLET

Gentian violet	gm
Alcohol	c
Aqua ad	100 c

It is useful in intertrigo and ... n ... e

LOTIO POTASSIUM PERMANGANATE

Pot permanganate	0 0 gm
Water	100 c c

LOTIO PLUMBI

Liq plumbi sub ... et (B P)	100
Water	8 fl oz

To apply in cases of weeping eczema.

LOTIO RESORCIN

Resorcin	4 ...
Ol ricini	10 m
Spt etheris	30 m
Spt lavendula	1 m
Spt rosmarini	1 m
Rose water ad	1 fl oz

To apply in ... lor ... oe ... c ... ti

LOTIO RESORCIN ET HYD PERCHLORIDE

Hg perchloride ... gr ... added to lotio resorcin

To apply on the scalp ... o ... l ... ... t

LOTIO SULPHURIS ALBA

Zinc sulphate	10 g
Potassium sulphide	10 gr
Glycerin	0 m
Water or rose water	1 fl oz

Lotio sulphuris flava and alba are efficacious in tinea versicolor, seborrhoea ... matitis ... ... and acne vulgaris.

LOTIO SULPHURIS FLAVA

Sulphur (Precipitated)	60 gr
Pulv Tragacanth ... o	10 gr
Water or rose water	1 fl o

LOTIO TRIPLE DYE

Acriflavine	0 1 gm
Brilliant green	0 25 gm
Gentian violet	0 ?5 gm
Water	100 c c

Useful in intertrigo monilia is athl tes foot tinea barbae sycosis barbae etc

LINIMENTS

LINIMENT CALAMINE

Calamina preparata	30 gr
Zinc oxide	30 gr
Phenol	3 gr
Oil amyg d l	4 dr
Liq calcis ad	1 fl oz

To apply on the patch of allergic or s l orr hoeic dermatitis irrit ibl skin etc

LINIMENT CALAMINE WITH ICHTHYOL

Ichthyol	10 gr
Liniment calamin	1 fl oz

Efficacious in seborrho ic lerm ititi

LINIMENT CALAMINE WITH SULPHUR

Sulphur (Precipitate l)	10 gr
Liniment calamine ad	1 fl (

PAINTS

RINGWORM PAINT

Resorcin	1 oz
Aci l salicylic	1 oz
A i l carbolic	1 oz
Aci l aceti	1 fl oz
Glycerine	½ oz
Phenyl merc uric a etate	gr
Tinctur benzoin co	4 oz

To apply on th e p rs tent pat l e of ring worm of the body

PIGMENT RESORCIN BENZOIN CO

Re orcin	60 gr
Tincture benzoin o n l	1 fl oz

To apply on the ringworm patches inclu ling inter ligital ringworm

PIGMENT FUCH IN (ASTELLANI S PAINT)

Basic fuch in sat alcoholi sol 10 c	
per cent a q ol phenol	100 c
Bori a i l	1 gm
Acetone	c c
Resorcinol	1 gm

Carbol Fuchsin —

Basic fuchsin sat alcoholic sol	10 c c
Phenol	5 gm
Water	100 c c

Add boric acid to filtere l carb l fuchsin after hours add c c of acetone an l hours later a ld 10 gm of resorcinol Keep in a dark stoppered bottle

Apply on athlete s foot r ringworm of the nail

PIGMENT THYMOL CINNAMON OIL AND IODINE

Thymol	10 gr
Cinnamon oil	10 gr
Tincture iodi miti a l	1 fl oz

To apply on the ringworm of the s alp an l beard are s

POWDERS

PULV SULPHUR ET AMPHOR

Sulphur (precipitated)	
Camphor	
Zinc oxi l	
Boric aci l a l	10 gr
Pulv amylum et talcum a l	1 oz

To l e l i pen e l in a p rforated powd r can To dust on the aff te l reas of seborrh ic patche prickly l eat an l a a prophylacti in inter l gital ringworm inf tion

UNDE YLE ATE POWDER

Zinc un l cyl nate	0 p rt
Un lecyle i a i l	p rt
Pulv talcum	s part

This shoul l be u l as a prophylactic in tinea cruris an l inter l gital ringworm

DESONEX POWDER

Zinc un lecylenate	part
Undecylen i a i l	part
Tal um pow l r	1 0 part

To be lu t l on r of ringwo m a prophyl cti p w ler

PR PI NATE POWDER

Cal ium propionat	1 p t
Zin propionate	p rts
Pul tal um	part

To apply locally or th a of i w rm a a prophylacti pow l r

SHAMPOO

SPIRIT AETHER SOAP SHAMPOO

Sapo vir d	1 o
Aether	
Al ohol or rectifed pirit eacl	1 o

To app ly on the scalp by rubb ng thorou ghly an l then to wasl Tl is sl o ıl l be done twi e weekly in seborrl oea cap ti an l psoriasi

SPIRIT

SPIRIT RESORCIN ET HG PER LORII E

Hg percl loride	½ gr
Re orc n	1 gr
Spirit vinum rect	1 0 m
Water a l	1 fl o

To be ap pl ed ı kly 1 t mm l oils et

UNGUENTUM (Ointment)

UNGUENTUM DITHRANOLIS

D thranol	0 gm
Paraffin molle	)J gm

To ap ply on ı t l of ri gwo n n l ı s ı

Tl e stre gtl e n l ı ı reas d f tol rat l Its a t on ıs l ke tl at of cl rysarol ı l ut it s r 4 t mes mo e ct ve th n ıt

UNGUENTUM HG AM ON DIL

Hy lra g mmon	to 1 l g
Hyd ou ointm nt a l	l

Effe ıo ın mpetig

UNGUENTUM WHITFIELI

Aci l benzoı	20 gr
Aci l sal cylic	10 gr
Ol coco	4 dr
Paraffin durum	2 dr

Pr pare tl e ba e fi t by melting an l tl en add other ingre lients

To apply on the ringworm of the groin and otl r sens tive parts of the body

UNGUENTUM IODI

Iodine (Crystal)	5 parts
Lanolin a l	100 part

To apply locally as antiseptic or counter irritant

Q I OLCR COMPOUND OINTMENT (Squ bb)

Chlorol ydroxyquinol n	0 5 part
B nzoyl pe ox de	10 0 parts
Aromatic oil	0 24 parts
Veh le (Inert) ad	100 part

To apply n ca es of sycos ba l ae

UNGUENTUM AUREOMYCIN

3 per e nt aureomycin n wat r solubl bas

Len ıll n o ntment B l

UNGUENTUM SODIU I PROPIONATE

Sodium prop onat	16 4 p t
Prop onic acid	3 6 parts
N propyl alcol ol	10 0 p ts
Z n stea ate	0 pa ts
C bo wax 4000	0 pa t

For prophylaxis of rin wo m

DESONEX OINTMENT

Z nc undec l n t	1 p t
Und yl n a d	3 parts
Wat lubl b o	60 pa t

For p opl ylax of in wo

INDEX

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